THURSDAY, JANUARY 23, 1873

THE NAVY AND SCIENCE

IT would be difficult to estimate the many excellent effects that are likely to result from the establishment of the Royal Naval College, which, as has been at last authoritatively intimated, is to be opened on February 1, in those noble halls at Greenwich that for so long have been associated in another way with the British Navy. Her Majesty's Government deserve the highest praise for the wisdom—provokingly tardy though it has been—displayed in the thorough and handsome provision they have made for the scientific education of our naval officers. Much that is sarcastic, no doubt, might be said on this tardiness of a Government which seldom moves until it is driven; but as we fear this would do little good, we shall only express a hope that in future when they are compelled to take action in any matter, especially if it be scientific, they will do so as decidedly and sweepingly as they have done in the present instance.

It is usually acknowledged that the very existence of Britain as a first-rate Power depends upon the efficiency of her navy, and yet it is a lamentable fact that hitherto no nation in the world of any consequence has made less systematic provision for the training of the members of her navy than has our own. Our naval officers and seamen have been left pretty much to haphazard to gain a knowledge of their profession, and, indeed, until recently it would have been generally thought derogatory to what is vaguely known as "British pluck," had it been hinted that it would be not less plucky were it well informed; that it would have a better chance to beat all the forces in the universe, did it know the scientific principles on which a few of these forces rested. Happily this is no longer the case; the strong light of science, "the irresistible logic of facts," has shown this old knowledge to be but ignorance; and let us rejoice that this great light has at last dawned upon the magnates of our navy, and dispersed the great darkness in which they have for so long sat. The college to be opened on Feb. 1, if we may judge from the prospectus, will furnish as thorough a scientific education in the branches to be taught as can be obtained at any similar institution in any country in the world.

The immense advantages that are likely to accrue to the British Navy as such, from the excellent training which its officers must undergo at the new Naval College, are evident to all, and have been already pointed out in the columns of the general press. For one thing it will reduce the incompetents and idlers to a minimum. We are inclined to think that the gains to Science from the establishment of such an institution will be of not less importance than the increase in the efficiency of the navy which must be its special result. Our naval officers form a large, important, and influential body, having opportunities for scientific research all over the world which all students of nature must envy. Even under the old *régime* many of the most important additions to scientific knowledge in various departments were made by naval officers, some of whom have won for themselves deathless names as scientific explorers. What then must be the conquests of Science in the future when every naval officer who is capable of profiting by the instruction to be furnished at Greenwich will go forth trained and equipped to wrest from Nature some of the many secrets which she still holds in her grasp? What an immense advantage must it be to any scientific or exploring expedition when the officers that command the ship are as capable of unravelling the mysteries of Nature as they are of boxing the compass. But it would be impossible to enumerate all the advantages that we may reasonably expect to accrue to Science from the step taken by the Lords of the Admiralty. The scheme of education as it stands on paper is admirable, and most comprehensive as to subject and as to the classes for whose advantage it has been drawn out; with Rear-Admiral Kay as President of the College, and Dr. Hirst as Director of Studies, we have every reason to hope that the Royal Naval College will "become, not only an educational establishment affording the means of the highest training in theoretical subjects to naval officers of all classes, but also a nucleus of mathematical and mechanical science specially devoted to those branches of scientific investigation which have most interest for the navy."

We can only hope that the excellent example set by the Lords of the Admiralty will in a very short time be followed by the authorities of the War Office. Does not the profession of a military officer at the present day require as thorough a training to be able to fill it efficiently, as does that of a naval officer? Are not the very highest scientific principles being brought to bear on the elaboration of military weapons, and military tactics? and would not military officers, like naval officers, perform the duties of their profession more efficiently if they had a systematic training in the sciences from which modern tactics draw their life? But sad to say, the military authorities have recently shown a tendency to take the very opposite course to that which our more advanced naval authorities have so commendably followed. We hope the example of the latter will ere long shame the former into mending their ways.

The following are some of the principal points in the minute issued by the Lords of the Admiralty:—

"The College, subject to the subjoined Regulations, will be open to officers of the following ranks:—1. Captains and Commanders. 2. Lieutenants. 3. Navigating Officers. 4. Naval Instructors. 5. Acting Lieutenants and Acting Sub-Lieutenants. 6. Officers, Royal Marine Artillery; ditto, Royal Marine Light Infantry. 7. Officers of the Engineer Branch, viz.:—Chief Engineers, Engineers, 1st Class Assistant Engineers, Acting 2nd Class Assistant Engineers. 8. A limited number of Dockyard Apprentices will be annually selected, by competitive examination, for admission to the College. A course of instruction at the College will also be open to a limited number of:—9. Private students of Naval Architecture or Marine Engineering. 10. Officers of the Mercantile Marine.

"It is not intended to provide at Greenwich for the education of the Naval cadets. My Lords intend that the Royal Naval College at Greenwich shall be so organised as to provide for the education of naval officers of all ranks above that of midshipman, in all branches of theoretical and scientific study bearing upon their profession; but my Lords will continue the instruction given in the *Excellent* gunnery-ship as heretofore, and arrangements for instruction in practical surveying will also be con-

tinued at Portsmouth. My Lords desire by the establishment of the College, to give to the executive officers of the navy generally every possible advantage in respect of scientific education; but no arrangements will be made at all prejudicing the all-important practical training in the active duties of their profession. The object of securing, in the interest of the naval service, the highest possible scientific instruction is, in the opinion of my Lords, most effectually to be attained by bringing together in one establishment all the necessary means for the higher education of naval officers and of others connected with the navy. . . . Complete courses of study suitable for the different classes of students admitted will be organised, and will be carried out by professors, lecturers, and instructors. Officers and others admitted as students will have the advantage of these courses of study, whether they reside or not. But officers and others who may not become students will, under certain regulations, have free access to separate courses of lectures, the benefit of which it is desired to extend as far as possible."

The following are the proposed courses of study:—

"1. Pure Mathematics, including co-ordinate and higher Pure Geometry, Differential Calculus, Finite Differences, and the Calculus of Variations. 2. Applied Mathematics, viz., Pneumatics, Mechanics, Optics, and the Theories of Sound, Light, Heat, Electricity, and Magnetism. 3. Applied Mechanics, including the Theory of Structures, the principles of Mechanism, and the Theory of Machines. 4. Nautical-Astronomy, Surveying, Hydrography, with Maritime Geography, Meteorology, and Chart Drawing. 5. Experimental Sciences:—*a.* Physics, viz., Sound, Heat, Light, Electricity, and Magnetism; *b.* Chemistry; *c.* Metallurgy. 6. Marine Engineering, in all its branches. 7. Naval Architecture, in all its branches. 8. Fortification, Military Drawing, and Naval Artillery. 9. International and Maritime Law; Law of Evidence and Naval Courts Martial. 10. Naval History and Tactics, including Naval Signals and Steam Evolutions. 11. Modern Languages. 12. Drawing. 13. Hygiene—Naval and Climatic. A certain latitude in selecting such courses of study as they may prefer will be allowed to officers voluntarily attending the College. Officers and others required to attend by the Regulations will follow such courses of study as may from time to time be prescribed.

"The general organisation of the College will be as follows:—A flag officer will be president; he will be assisted by a captain in the Royal Navy in matters affecting discipline, and in the internal arrangements of the College unconnected with study. A director of studies will, under the president, organise and superintend the whole system of instruction, and the various courses of study. There will further be—A professor of mathematics, a professor of physical science, a professor of chemistry, a professor of applied mechanics, a professor of fortification. Such instructors in mathematics and the other branches specified as may be necessary to assist the professors will be added to the staff. Lecturers will be appointed to deliver courses of lectures in naval architecture, metallurgy, civil and hydraulic engineering, maritime law, naval history and tactics, and hygiene. A naval officer will conduct instruction in nautical astronomy and surveying, and there will be two instructors in steam. Such provision will be made for instruction in French and German and in drawing, as the number of students desirous of following courses in these branches may render necessary. . . .

"Arrangements have been made for the admission of naval engineer officers to the College, which will prevent time spent at the College from entailing any pecuniary loss upon them. The School of Naval Architecture at South Kensington will be absorbed in the Royal Naval College, Greenwich. The regulations for the admission of engineer students and of dockyard apprentices have been so framed as to provide as nearly as possible the same aggregate time for their instruction as that which is now afforded at South Kensington. Further regulations will be issued by their lordships in regard to the admission of private students to the course of study at the College on similar conditions to those now existing at South Kensington. My Lords have further determined to admit a limited number of officers of the Mercantile Marine as students of the College, enjoying the full advantages of the whole course of instruction and tuition by the educational staff, while officers of the Mercantile Marine generally will, on application, be allowed to attend courses of lectures.

"The paramount object which my Lords have pursued in the organisation of the College has been to provide the most efficient means for the higher education of naval officers adequate to the constantly increasing requirements of the service; but my Lords also anticipate great advantages from the results likely to accrue from the connection which will be established through the College between men distinguished in the various departments of mathematical, physical, and chemical science, and those practical problems which so vitally interest the navigator, the naval architect, and the naval engineer. My Lords expect the College to become, not only an educational establishment affording the means of the highest training in theoretical subjects to naval officers of all classes, but also a nucleus of mathematical and mechanical science specially devoted to those branches of scientific investigation which have most interest for the navy."

ELECTROSTATICS AND MAGNETISM

Reprint of Papers on Electrostatics and Magnetism. By Sir W. Thomson, D.C.L., LL.D., F.R.S., F.R.S.E., Fellow of St. Peter's College, Cambridge, and Professor of Natural Philosophy in the University of Glasgow. (London: Macmillan and Co., 1872.)

TO obtain any adequate idea of the present state of electro-magnetic science we must study these papers of Sir W. Thomson's. It is true that a great deal of admirable work has been done, chiefly by the Germans, both in analytical calculation and in experimental researches, by methods which are independent of, or at least different from, those developed in these papers, and it is the glory of true science that all legitimate methods must lead to the same final results. But if we are to count the gain to science by the number and value of the ideas developed in the course of the inquiry, which preserve the results of former thought in a form capable of being employed in future investigation, we must place Sir W. Thomson's contributions to electro-magnetic science on the very highest level.

One of the most valuable of these truly scientific, or *science-forming* ideas, is that which forms the subject of the first paper in this collection. Two scientific problems, each of the highest order of difficulty, had hitherto been considered from quite different points of view. Cavendish and Poisson had investigated the distribution of electricity on conductors on the hypothesis that the particles of electricity exert on each other forces which vary inversely as the square of the distance between them. On the other hand Fourier had investigated the laws of the steady conduction of heat on the hypothesis that the flow of heat from the hotter parts of a body to contiguous parts which are colder is proportional to the rate at which the temperature varies from point to point of the body. The physical ideas involved in these two problems are quite different. In the one we have an

attraction acting instantaneously at a distance, in the other heat creeping along from hotter to colder parts. The methods of investigation were also different. In the one the force on a given particle of electricity has to be determined as the resultant of the attraction of all the other particles. In the other we have to solve a certain partial differential equation which expresses a relation between the rates of variation of temperature in passing along lines drawn in three different directions through a point. Thomson, in this paper, points out that these two problems, so different, both in their elementary ideas and their analytical methods, are mathematically identical, and that, by a proper substitution of electrical for thermal terms in the original statement, any of Fourier's wonderful methods of solution may be applied to electrical problems. The electrician has only to substitute an electrified surface for the surface through which heat is supplied, and to translate temperature into electric potential, and he may at once take possession of all Fourier's solutions of the problem of the uniform flow of heat.

To render the results obtained in the prosecution of one branch of inquiry available to the students of another is an important service done to science, but it is still more important to introduce into a science a new set of ideas, belonging, as in this case, to what was, till then, considered an entirely unconnected science. This paper of Thomson's, published in February 1842, when he was a very young freshman at Cambridge, first introduced into mathematical science that idea of electrical action carried on by means of a continuous medium which, though it had been announced by Faraday, and used by him as the guiding idea of his researches, had never been appreciated by other men of science, and was supposed by mathematicians to be inconsistent with the laws of electrical action, as established by Coulomb, and built on by Poisson. It was Thomson who pointed out that the ideas employed by Faraday under the names of Induction, Lines of Force, &c., and implying an action transmitted from one part of a medium to another, were not only consistent with the results obtained by the mathematicians, but might be employed in a mathematical form so as to lead to new results. One of these new results, which was, we have reason to believe, obtained by this method, though demonstrated by Thomson by a very elegant adaptation of Newton's method in the theory of attraction, is the "Method of Electrical Images," leading to the "Method of Electrical Inversion."

Poisson had already, by means of Laplace's powerful method of spherical harmonies, determined, in the form of an infinite series, the distribution of electricity on a sphere acted on by an electrified system. No one, however, seems to have observed that when the external electrified system is reduced to a point, the resultant external action is equivalent to that of this point, together with an imaginary electrified point within the sphere, which Thomson calls the *electric image* of the external point.

Now if in an infinite conducting solid heat is flowing outwards uniformly from a very small spherical source, and part of this heat is absorbed at another small spherical surface, which we may call a *sink*, while the rest flows out in all directions through the infinite solid, it is easy, by Fourier's methods, to calculate the stationary temperature at any point in the solid, and to draw the isothermal surfaces. One of these surfaces is a sphere, and if, in the electrical problem, this sphere becomes a conducting surface in connection with the earth, and the external source of heat is transformed into an electrified point, the sink will become the *image* of that point, and the temperature and flow of heat at any point outside the sphere will become the electric potential and resultant force.

Thus Thomson obtained the rigorous solution of electrical problems relating to spheres by the introduction of an imaginary electrified system within the sphere. But this imaginary system itself next became the subject of examination, as the result of the transformation of the external electrified system by reciprocal *radii vectores*. By this method, called that of electrical inversion, the solution of many new problems was obtained by the transformation of problems already solved. A beautiful example of this method is suggested by Thomson in a letter to M. Liouville, dated October 8, 1845, and published in *Liouville's Journal*, for 1845, but which does not seem to have been taken up by any mathematician, till Thomson himself, in a hitherto unpublished paper (No. xv. of the book before us), wrote out the investigation complete. This, the most remarkable problem of electrostatics hitherto solved, relates to the distribution of electricity on a segment of spherical surface, or a *bowl*, as Thomson calls it, under the influence of any electrical forces. The solution includes a very important case of a flat circular dish, and of an infinite flat screen with a circular hole cut out of it.

If, however, the mathematicians were slow in making use of the physical method of electric inversion, they were more ready to appropriate the geometrical idea of inversion by reciprocal *radii vectores*, which is now well known to all geometers, having been, we suppose, discovered and re-discovered repeatedly, though, unless we are mistaken, most of these discoveries are later than 1845, the date of Thomson's paper.

But to return to physical science, we have in No. vii. a paper of even earlier date (1843), in which Thomson shows how the force acting on an electrified body can be exactly accounted for by the diminution of the atmospheric pressure on its electrified surface, this diminution being everywhere proportional to the square of the electrification per unit of area. Now this diminution of pressure is only another name for that *tension* along the lines of electric force, by means of which, in Faraday's opinion, the mutual action between electrified bodies takes place. This short paper, therefore, may be regarded as the germ of that course of speculation by which Maxwell has gradually developed the mathematical significance of Faraday's idea of the physical action of the lines of force.

We have dwelt, perhaps at too great length, on these youthful contributions to science, in order to show how early in his career, Thomson laid a solid foundation for his future labours, both in the development of mathematical theories and in the prosecution of experimental research. Mathematicians however will do well to take note of the theorem in No. xiii., the applications of which to various branches of science will furnish them, if they be diligent, both occupation and renown for some time to come.

We must now turn to the next part of this volume, in which the mathematical electrician, now established as a Professor at Glasgow, turns his attention to the practical and experimental work of his science. In such work the mathematician, if he succeeds at all, proves himself no mere mathematician, but a thoroughly furnished man of science. And first we have an account of that research into atmospheric electricity which created a demand for electrometers; then a series of electrometers of gradually improving species; and lastly, an admirable report on electrometers and electrostatic measurements, in which the results of many years' experience are given in a most instructive and scientific form. In this report the different instruments are not merely described, but classified, so that the student is furnished with the means of devising a new instrument to suit his own wants. He may also study, in the recorded history of electrometers, the principles of natural selection, the conditions of the permanence of species, the retention of rudimentary organs in manufactured articles, and the tendency to reversion to older types in the absence of scientific control.

A good deal of Sir W. Thomson's practical electrical work is not referred to in this volume. It is to be hoped that he will yet find time to give some account of his many admirable telegraphic contrivances in galvanometers, suspended coils, and recording instruments, and to complete this collection by his papers on electrolysis, measurement of resistance, electric qualities of metals, thermo-electricity, and electro-magnetism in general.

The second division of the book contains the theory of magnetism.

The first paper, communicated to the Royal Society in 1849 and 1850, is the best introduction to the theory of magnetism that we know of. The discussion of particular distributions of magnetisation is altogether original, and prepares the way for the theory of electro-magnets which follows. This paper on electro-magnets is interesting as having been in manuscript for twenty-three years, during which time a great deal has been done both at home and abroad on the same subject, but without in any degree trenching upon the ground occupied by Thomson in 1847. Though in these papers we find several formidable equations bristling with old English capitals, the reader will do well to observe that the most important results are often obtained without the use of this mathematical apparatus, and are always expressed in plain scientific English.

As regards the most interesting of all subjects, the history of the development of scientific ideas—we know of few statements so full of meaning as the note at p. 419 relating to Ampères' theory of magnetism, as depending on electric currents, flowing in circuits within the molecules of the magnet; he goes on to say:—

"From twenty to five-and-twenty years ago, when the materials of the present compilation were worked out, I had no belief in the reality of this theory; but I did not then know that motion is the very essence of what has been hitherto called matter. At the 1847 meeting of the British Association in Oxford, I learned from Joule the dynamical theory of heat, and was forced to abandon at once many, and gradually from year to year all other, statical preconceptions regarding the ultimate causes of apparently statical phenomena."

After a short, but sufficient, proof that the magnetic rotation of the plane of polarised light discovered by Faraday implies an actual rotatory motion of something, and that this motion is part of the phenomenon of magnetism, he adds:—

"The explanation of all phenomena of electro-magnetic attraction or repulsion, and of electro-magnetic induction, is to be looked for simply in the inertia and pressure of the matter of which the motions constitute heat. Whether this matter is or is not electricity, whether it is a continuous fluid interpermeating the spaces between molecular nuclei, or is itself molecularly grouped; or whether all matter is continuous, and molecular heterogeneousness consists in finite vortical or other relative motions of contiguous parts of a body; it is impossible to decide, and perhaps in vain to speculate, in the present state of science."

The date of these remarks is 1856. In 1861 and 1862 appeared Maxwell's "theory of molecular vortices applied to magnetism, electricity, &c." which may be considered as a development of Thomson's idea in a form which, though rough and clumsy compared with the realities of nature, may have served its turn as a provisional hypothesis.

The concluding sections of the book before us are devoted to illustrations of magnetic force derived from the motion of a perfect fluid. They are not put forward as *explanations* of magnetic force, for in fact the forces are of the opposite kind to those of magnets. They belong more properly to that remarkable extension of the science of hydrokinetics which was begun by Helmholtz and so ably followed up by Thomson himself.

The conception of a perfectly homogeneous, incompressible frictionless fluid is as essential a part of pure dynamics as that of a circle is of pure geometry. It is true that the motions of ordinary fluids are very imperfect illustrstions of those of the perfect fluid. But it is equally true that most of the objects which we are pleased to call circles are very imperfect representations of a true circle.

Neither a perfect fluid nor a perfect circle can be formed from the materials which we deal with, for they are assemblages of molecules, and therefore not homogeneous except when regarded roughly in large masses. The perfect circle is truly continuous and the perfect fluid is truly homogeneous.

It follows, however, from the investigations of Helmholtz and Thomson that if a motion of the kind called *rotational* is once set up in the fluid, the portion of the fluid to which this motion is communicated, retains for ever, during all its wanderings through the fluid mass, the character of the motion thus impressed on it.

This *vortex* then, as Helmholtz calls it, be it large or small, possesses that character of permanence and individuality which we attribute to a material molecule, while at the same time it is capable, while retaining its essential characteristics unchanged both in nature and value, of changing its form in an infinite variety of ways, and of executing the vibrations which excite those rays of the spectrum by which the species of the molecule may be discovered. It would puzzle one of the old-fashioned little round hard molecules to execute vibrations at all. There was no music in those spheres.

But besides this application of hydrokinetics to this new conception of the old atom, there is a vast field of high mathematical inquiry opened up by the papers of

Helmholtz and Thomson. It is to be hoped that the latter will soon complete his papers on *Vortex Motion* and give them to the world. But why does no one else work in the same field? Has the multiplication of symbols put a stop to the development of ideas?

OUR BOOK SHELF

Natural History Transactions of Northumberland and Durham. Vol. IV. Part II. (Williams and Norgate.)

THIS volume of upwards of 250 pages confirms the reputation already attained by the Tyneside Naturalists' Field Club, as being one of the most efficient provincial scientific societies in the kingdom. Nearly all the papers are of real and permanent value, and it is to be hoped that ere long some means will be found of bringing the work of this and similar societies before a larger public than is likely to be reached by "Transactions," which are seldom seen by any but the members or their friends. A large part of the volume is devoted to the excellently compiled Meteorological Reports for 1870 and 1871, by the Rev. R. F. Wheeler, M.A. There is here much valuable material, more interestingly and artistically put together than such reports usually are. Mr. T. J. Bold contributes a well-arranged catalogue of 151 species of *Hemiptera-Heteroptera* of Northumberland and Durham. Mr. Bold contributes besides many valuable notes on various other kinds of insects found in the district so well worked by the Tyneside society; Mr. Bold deserves the highest credit for the quantity and quality of his work. Messrs. A. Hancock and T. Atthey describe a considerable portion of a Mandibular Ramus of *Anthracosaurus Russelli* (Huxley), found in the new ironstone shale of Fenton; they also add some notes on *Loxomma Almanni* (Huxley), and on some additional remains of *Archichthys Sulcidens* (Hancock and Atthey), recently found at Newsham. The same gentlemen contribute a few remarks on *Dipterus* and *Ctenodus*, and on their relationship to *Ceratodus Forsteri* (Krefft). A well-arranged list of the non-parasitic marine *Copepoda* of the north-east coast of England is Mr. G. S. Brady's contribution to the volume. The President's address, consisting mainly of a graphic account of the numerous club excursions during 1871, is the last paper in the volume, one of the most valuable features of which is the numerous and carefully executed lithographs which are appended. Nearly every paper is illustrated. Altogether it is a thoroughly satisfactory specimen of work.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Phosphorescence in Fishes

THE only reliable observations of active phosphorescence in fishes during life, known to the writer, are the following, to which, perhaps, may be added, the somewhat obscure observations on *Hemiramphus lucens*, communicated to G. Cuvier by Reinwardt:—

1. The observations of the two Bennetts ("Whaling Voyage" and "Gatherings in Australia") on a small luminous shark (*Squalus fulgens: Isistius brasiliensis*, Q.G.). (Perhaps also observed by Giglioli.)

2. The observations of J. Bennett on the luminosity of *Scopelus stellatus* (*l.c.*).

3. The luminosity of the head of *Astronesther niger* observed by Reinhardt (Videnskab. Meddel. f.d. naturhist. Forening: Kjöbenhavn, 1853).

Very probably the faculty is widely diffused among *Scopeloids* (*sensulatiore*), and Dr. Günther may be quite right in speaking of certain enigmatical organs in the skin of these fishes as their "luminous phosphorescent organs."

In Mr. Saville Kent's very sensible remarks on the phosphorescence (erroneously ascribed to several other fishes), in vol. vii. p. 47 of NATURE, I find a statement that startled me a little, viz., that "it has been proved beyond doubt that certain fish, *Cyclopterus lumpus*, for instance, do possess highly luminous properties" (during life, of course, or Mr. S. K. would not have mentioned it at all in this connection). I think that the observations regarding *Cyclopterus lumpus*, upon which this statement is based, are unknown to other zoologists than the writer, and that they would be much obliged to Mr. S. K. for a reference to his source of information.

Z.

Movements of the Earth's Surface

IT is, I believe, commonly supposed by geologists that the movements of the surface of the earth are caused by the refrigeration and contraction of the interior. But since the glacial epoch the surface of the earth has become warmer; consequently since that time a heat wave must have been passing from the surface towards the centre; and consequently since that time no refrigeration nor contraction of the interior can have taken place. If, therefore, movements of the earth's surface were due to this cause only, no such movements should have taken place since the glacial epoch.

F. W. HUTTON

Wellington, New Zealand, Nov. 10, 1872

Meteor Observed at Mauritius

ON Nov. 7 last, about 7 o'clock. P.M., I saw the most beautiful meteor fall that I ever remember observing in my life. My face was turned in the opposite direction, but an unusually brilliant and sudden flash of light, above the brightness of the moonshine, caused me to turn suddenly round in the direction the effulgence came from, and I saw a very large meteor majestically falling through the distance, seemingly of about eight or ten yards. I am not much of an astronomer, but I think it must have fallen, apparently, from some point in Aquarius. What particularly struck me in its appearance was that it was beautifully distinct, and round as the full moon, but seemingly about the $\frac{1}{4}$th of a diameter larger. I ought, perhaps, rather to compare it to the moon at the end of her first quarter. [See p. 231 of this Number.]

A quarter of its disc only was luminous and brilliant, while the upper three-quarters emitted no luminosity, being of a dull, dusky, stone-brown colour. Here the circular outline was perfectly distinct, while the brightness of the lower limb took away all distinctness of outline there, making it appear slightly more prominent, besides throwing beyond the outline of the meteor itself a beautiful soft, steady, very bright radiance of a bluish white tint, which illuminated momentarily the whole heavens. It was observed by other people, and one person described to me having seen a similar meteor fall about this time last year, the disc appearing "about the size of a saucer," entirely luminous, but then no moon was shining.

W. WRIGHT

Moon's Surface

MAY not the white, telescopic appearance of the moon's surface, resembling snow in many parts, be explained by the fact that the extinct volcanoes of our satellite are covered with crystals of salt?

Any person who is accustomed to view the moon through a telescope must, I think, have been struck with the dazzling snow-white appearance of the mountains. May not an explanation of this be deduced from the experiences gained by the last eruption of Vesuvius?

"One of the most curious phenomena observed is the power of burning lava to retain an enormous quantity of water and salt, which it does not allow to escape till it begins to cool. . . . The formation of salt is shown generally over the whole stretch of lava emitted in 1872. Soon after the surface cools it is covered with a light crust of salt."—*See* NATURE, vol. vii. p. 2.

Is it not, therefore, probable that the numerous lava beds of the extinct volcanoes in our satellite may be coated with salt, bleached to the whiteness of snow?

C. H. W. MERLIN

British Consulate, Athens, Nov. 23

The Twinkling of the Stars

EVERY one who observes the stars at all must have noticed that they twinkle much more on some nights than on others, and this irrespective of any sensible difference in the clearness of sky or air. On rare occasions the twinkling becomes a really striking phenomenon, and at such times it is interesting to note the series of changes which together make up a "twinkle." For this purpose it is convenient to select two stars of suitable size and distance apart, and to look steadfastly at one, while the attention is directed to the other. The star which is not looked at will become alternately visible and invisible, and the manner in which these changes succeed each other will be found rather remarkable.

On the evening of the 1st of the present month, observing an unusual degree of twinkling, I made the above experiment on the stars ε (Epsilon) and ζ (Zeta) of Ursa Major. Looking steadily at either one of these, I noticed that the other, which was normally quite apparent, became every now and then totally invisible, and that not for an instant, but for a period of some duration. On one occasion I actually counted 30 in the interval of disappearance, and this I found afterwards to correspond to five seconds. More frequently, the star would be invisible for one or two seconds, then suddenly flash into full brilliancy, and after a variable interval vanish as suddenly again.

From this it would appear that a "twinkle," at least when strongly marked, may be resolved into a sudden accession of brightness following a more or less prolonged period of comparative obscuration.

Stars may easily be found which will show the phenomenon I have described, even more strikingly than the two above named. I once tried two of the bright stars in Orion, and in this case the apparent sudden and absolute extinction, from time to time, of a conspicuous object, produced an effect almost startling.

Clifton, Dec. 12 GEORGE F. BURDER

Logarithmic Tables

THE general procedure in determining numerical values in a scientific investigation is as follows. From a few observations we first compute the approximate values of certain constants, using for this purpose a theory which is purely a mathematical fiction; and then, secondly, by comparison with extended series of observations we form equations of conditions, and determine the small corrections required by the approximate values of the constants. In the first part of this work logarithms of seven or more decimal places are necessary, but in the second part, which is generally by far the most laborious, logarithms of four and five decimals can be extensively used. Hence it is important that we should have well-arranged and convenient tables of such logarithms. An objection to nearly all the small tables that I have seen is that they are encumbered with tables that are not necessary to, or which do not properly accompany a table of logarithms, such as anti-logarithms, tables of meridinal parts, &c., and the result is that the logarithmic tables are made inconvenient for use.

In the logarithmic tables recently edited by Prof. J. M. Peirce, (Ginn Brothers, Boston, 1871), the arrangement of the logarithms of numbers and of the Gaussian logarithms leaves nothing to be desired, and the method of printing the agreement in larger type is a good one. In his table of the trigonometric functions Prof. Peirce has also introduced a good idea in giving the double argument, *arc* and *time*. This arrangement of the trigonometric function is however different from the one generally given, and hence for a computer accustomed to the common table is not convenient. I think that a table of four figure logarithms, in which the logarithms of numbers and the Gaussian logarithms should be printed after the arrangement and with the excellent type and paper adopted by Prof. Peirce, and with the trigonometric functions arranged in the common order with the double argument *arc* and *time*, and which should contain *nothing else*, is a desideratum.

For tables of five decimal places I would follow the same order of arrangement, but would print the argument to the trigonometric function in arc only, and would add a small table of squares for use in least square work. ASAPH HALL

Washington, Nov. 9

"Will-o'-the-Wisps"

PROF. GEIKIE, in his introductory lecture of the Murchison Chair of Geology at Edinburgh, which appeared in NATURE, vol. vii. p. 184, mentions that he never had the good fortune to encounter one of these legendary sprites. It may not be uninteresting to some of your readers to know that they are still extant. On October 5 last I was walking to the "Lizard" with a friend, and near Ruan Major we saw a light travelling fast over the country, which my friend took to be the light of a dog-cart. As there was no road in the neighbourhood we watched, and soon saw two others rising from the same place and bounding over the country till they seemed to be about thirty feet from the ground in a swampy field opposite us, when they disappeared. Another rose from the other side of the field, and after reaching the middle of the field, it also disappeared. In about ten minutes we saw five or six, but none afterwards.

I have asked several farmers of the district and many of my friends if they had ever seen any, but have only met with one farmer who said that when a boy he used to see them on Goonhilly Downs adjoining. The geological formation of this district is serpentine. HOWARD FOX

Falmouth, Jan 15

Spectroscopic Observations

IN corroboration of Capt. Herschel's statements regarding the mistaken idea of high dispersive power being essential to success in observations of solar prominences, I beg to give a few results obtained by a direct-vision spectroscope of dispersive power insufficient to separate D.

An object glass of 2″ diameter and 2′ 5½″ focal length (solar) was attached to this spectroscope in January last; and on the first observation—using coloured glass that absorbed rays from B to a point rather less refrangible than F—the latter line was found bright at four points on the sun's periphery, the slit being placed radial as well as tangential to the limb.

Since then I have frequently observed prominences with and without the coloured glass, and on one occasion obtained G bright. In this case the prominence, which occurred on the day preceding the binocular eclipse of June last, was a small one, but C, the line near D, and F, were all intensely vivid.

By the same spectroscope can be observed the brilliant lines of γ Argus, as also the principal lines of a large number of stars, without using a cylindrical lens.

At the red end of the spectrum I have obtained a broad belt of atmospheric absorption lines still less refrangible than the solar line that lies beyond the double atmospheric band on the red side of A.

I do not quite agree with Captain Herschel in attributing nothing to an Indian atmosphere, for the air here is doubtless more homogeneous than in the variable climes of Europe, but his protest against the prevalent notion of instruments of small dispersion being worthless for solar observations cannot be too widely circulated.

Many valuable data have probably been lost to science by observers being unaware of the power of the instruments at their disposal to work out the problems of nature.

Mangalore, Nov. 26 E. W. PRINGLE

GEORGE CATLIN

MR. GEORGE CATLIN, whose death we referred to last week, died in Jersey City on the 23rd of December last, after a lingering and painful illness. Mr. Catlin was born at Wilksbarre, Pennsylvania, on the 26th of July, 1796.

Mr. Catlin began the series of Indian paintings which has made his name so well known everywhere, when accompanying Governor Clark, of St. Louis, in the years 1830 and 1831, while he was engaged in making treaties with several Indian tribes. In 1832 he ascended the Missouri to Fort Union, and afterward returned in a canoe with two companions, a distance of 2,000 miles, visiting and painting all the tribes, so numerous at that time on the whole length of the river. Between this and 1847 he made several extended journeys among various North American tribes, often sailing hundreds of miles in a bark canoe.

By this means he accumulated a large number of paintings representing the portraits of the principal men of the tribes, and pictures of savage life, which were exhibited by him in various parts of the United

States. He then opened his collections in London and Paris. He was occupied in their display until 1852, when he went to Venezuela, and visited the Oronoco, Amazon, and Essequibo, taking a great number of pictures on his route. He afterwards crossed the continent to Lima, and going northward visited the mouth of the Columbia River, Nootka Sound, Alaska, and Kamtschatka. From Vancouver Island he went to the Dalles, and up the Columbia River to Walla Walla, thence to the Salmon River Valley, and across the mountains into Snake River Valley at Fort Hall, thence to the Great Falls of the Snake River, and returning to Portland, proceeded to San Francisco and San Diego. From San Diego he crossed the Colorado of the West and the Rocky mountains, and descended the Rio Grande del Norte in a canoe to Matamoras.

From Matamoras he set out for Sisal, in Yucatan, and thence proceeded to Havre. Returning from that place in the fall of the same year (1855), he went to Rio Janeiro and Buenos Ayres. Ascending the Paraguay and the Parana, he crossed the "Entre Rios" mountains to the head waters of the Uruguay, which he descended to the mouth of the Rio Negro, and returned again to Buenos Ayres. From this place in 1856 he coasted the whole length of Patagonia, and then north to Panama; thence to Chagres, to Caraccas in Venezuela, to Santa Martha, and Maracaibo. It is probable that this closed his active explorations, as he soon went back to Europe, where he stayed until a year or two ago, when he returned to this country. Continually accumulating paintings in all his expeditions, their aggregate was very great, and on opening an exhibition of the greater part of them in the museum of the Smithsonian Institution in the winter of 1871 and 1872, they attracted great attention from visitors. They are now boxed up in that institution, awaiting disposal. Mr. Catlin's object in bringing them to Washington was to secure an appropriation from Congress for their purchase, this to include the remainder of his collection, which is now in Philadelphia.

The paintings of Mr. Catlin, although far from being unexceptionable as works of art, are of very great value as ethnological representations; and it is very much to be hoped that some measures may be taken to get the entire collection permanently preserved and studied. Especially in view of the fact that by far the greater number of the North American tribes included in his representations have either become exterminated or have changed their habits of life, the interest and value of Mr. Catlin's faithful portraitures may well be realised.

The first work published by Mr. Catlin was entitled, "Illustrations of the Manners, Customs, and Condition of the North American Indians, written during Eight Years of Travel and Adventure among the wildest and most remarkable Tribes now existing." This was illustrated with over three hundred steel-plate engravings from his gallery, and has long been a work of reference on subjects connected with the American aborigines, having passed through a number of editions. Some of his other works were, "North American Portfolio of Hunting Scenes," "Notes of Eight Years' Travel and Residence in Europe," "Life among the Indians," "Okeepah," "The Subsided and Uplifted Rocks of North America," &c.

*ON THE OLD AND NEW LABORATORIES AT THE ROYAL INSTITUTION**

A TIME when, through temporary absence from one chair, and through a change of occupancy of the other, we are deprived of the presence of our two Professors, seems to offer an opportunity for reviewing the past history, the scientific results, and the future prospects of our laboratories. A time when, through circumstances which cause us much regret, we are deprived, at our evening meetings at least, of the presence of our Secretary, offers perhaps the only occasion when the task of such a review could fall to other hands than his. The fact that it has fallen to mine is attributable to the office in which your votes have placed me, rather than to any individual qualifications of my own. And it would have been impossible for me to undertake the task, had he not placed at my disposal his wide-spread information upon many branches of science, as well as his intimate knowledge of the history of the Institution, to the well-being of which his care and devotion have so largely contributed.

The first dawn of our history is to be sought among those stormy years with which the last century drew towards its close, and out of which many new thoughts and aspirations of men took their birth.

Its character, in accordance with the views of its early promoter, Count Rumford, was at first far more industrial than it eventually became. Its two great objects were "the general diffusion of the knowledge of all new and useful improvements, and teaching the application of scientific discoveries to the improvement of arts and manufactures, and to the increase of domestic comfort and convenience." The Institution was to contain models, or actual specimens of fire-places and kitchen utensils for cottages, farm-houses, and large dwellings; a complete laundry for a gentleman's family; grates and chimney pieces; brewers' boilers; distillers' coppers; ventilators; limekilns; steam-boilers; spinning wheels; agricultural implements; bridges, &c.; and at one time some eighteen or twenty young mechanics were actually boarded and lodged in the house. The records of our early proceedings give an instance, illustrating the views of the founders. In January, 1800, when the designs for the theatre, model-room, and workshops were formed, the architect proposed that the laboratory should occupy the position which it ultimately held. But, with a view to giving more room to the workshops, the proposal was set aside in the very next month, and the space in the basement under the theatre assigned to the purpose. Happily, however, before the building had reached the first floor, this position was found unsuitable; and further consideration devised the laboratory, which we have all known so well as that of Davy, of Faraday, and of Tyndall. A staircase leading to it from the front hall, although long since closed, was removed only in 1866, to make room for Prof. Tyndall's smoke chamber.

From Count Romford's final departure from England in 1802 we may date the decline of the industrial element, some echo of which still rings in our motto, "Illustrans commoda vitæ;" and early in the following year a definite proposal to give up that part of the original plan was made.

From a report to the managers in 1803, it appears that, although chemistry had always been a primary object of the Institution, yet from motives of economy nothing more had been done in the way of either laboratory or apparatus than was necessary for the immediate purpose of the lectures. It was consequently proposed that the workshop should be added to the laboratory and fitted with seats for 120 persons, and the forge adapted to chemical purposes. The report ends as follows:—"This laboratory will be equal, or indeed superior, to any in this country, and probably to any on the Continent."

The chemical laboratory was altered in accordance with that report, and remained unchanged until 1863, when, on the appointment of Dr. Frankland to the Professorship of Chemistry, the lecture seats were removed so as to adapt the room more properly to purposes of scientific research.

It is interesting to contrast the verdict of 1873 with that of 1803. "Originally built," to quote Dr. Bence Jones's own words, "as a workshop for blacksmiths, fitted with a forge, and furnished with bellows which only last

* A lecture delivered on Friday evening last by William Spottiswoode, LL.D. Treasurer R.S. and R.I.

summer left the Institution, our chemical laboratory was probably the very worst in London."

The physical laboratory remained unchanged; and although Professor Tyndall for himself desired nothing more than to continue his researches in a place which his imagination filled with the recollections of his predecessors, he still acquiesced in the proposal for rebuilding, for the sake of his successors, and in the interest of the sister science of his colleague.

Thus much about the material fabric of our laboratories. Next as to the scientific work of which they have been the birthplace.

Of the great names connected with this building foremost in order of time, and very high in scientific rank, stands that of Dr. Thomas Young. His "Theory of Light and Colours" will always stamp him as one "whose genius has anticipated the progress of science," and whose reputation has risen as men have better understood his worth. His first paper on the subject was presented to the Royal Society in November, 1801; but the earliest printed account of his views is to be found in his "Syllabus of Lectures at the Royal Institution," dated January 19, 1802.

With the criticisms of his theory published in the *Edinburgh Review*, with the circumstances which led to his withdrawal from the Institution, with his researches in Egyptian hieroglyphics, we are not here concerned. But it is not too much to say of him, that without the Wave Theory of Light (of which he was one of the prime and main founders) to serve as a guiding-thread through the labyrinth of phenomena, the long series of discoveries which have in this place culminated in those of Tyndall in Radiation and Absorption, would have been impossible.

It is often remarked that little rills, which have threaded their way from distant mountains, ultimately discharge themselves as mighty streams into the sea. Yet between these two stages they flow quietly, but not therefore less usefully, past smiling meadows and the haunts of men, And here is a little scientific pastoral—if it may be so called—flowing out of the highest conceptions of the theory of undulations, and furnishing, to use his own words—a simple instrument "for measuring the diameters of the fibres of different kinds of wool."* [The lecturer then described and exhibited on the screen the principle of Dr. Young's eriometer.]

Our next name is that of Davy, an account of whose discoveries would require a volume, and a bare recital of them would be long. I quote the following notes from the pen of our Secretary, and wish that he had been here to give life to the dry bones.

In 1806, when twenty-eight years of age, Davy did the work which formed his first Bakerian Lecture, "On the Chemical Agencies of Electricity." Six years previously he had written, "Galvanism I have found, by numerous experiments, to be a process purely chemical." In the interim, water had been decomposed by electricity, and Davy began his researches with an inquiry into the changes produced in water by electricity. His main conclusion was that "the kind of polarity of each element determined the electrical and chemical actions shown by it." The French Academy awarded him a medal for this work; and from these discoveries the fame of our laboratories took its rise.

The next year Davy began a new series of experiments on Polarity. He exposed different substances to the action of platinum wires coming from a battery of 100 cells; and on October 6 he wrote in his note-book, "Remarkable phenomena with potash." On the 19th he made the following entry, "A capital experiment proving the decomposition of potash." He worked at the decomposition of other alkalies until the 23rd November, when he was attacked by a fever which proved nearly fatal to him.

* The King at this time had his flock of merino sheep, and Sir Joseph Banks had the care of them at Kew. On his recovery from his first mental attack the King would only call the P.R.S. his woolstapler.

The importance of these decompositions to the recent science of spectral analysis, although not dreamt of at the time, can hardly be overrated; and I will therefore venture to interrupt my narrative for a moment by an experiment,—a very well-known one, which will serve to illustrate the point. [The speaker then exhibited the dark absorption line of sodium; but so arranged as to show the dark line *in the centre of*, and not entirely obliterating, the bright line; proving that a certain density of vapour is necessary for complete absorption.]

In 1808 he began to work on the composition of muriatic acid; and with a new battery provided for him by subscription, he attacked different substances with increased energy. In 1810 he sent to the Royal Society his researches on oxymuriatic acid and the elements of muriatic acid, on what is in fact now known as chlorine.

In 1811 he made the acquaintance of Mrs. Appreece, and in 1812 wrote to his brother, "In a few weeks I shall be able to return to my habits of study and research. I am going to be married to-morrow, and have a fair prospect of happiness with the most amiable and intellectual woman I have ever known." The issue of these hopes has been written by his biographers; but the disappointment of the last seventeen years of his life is illuminated by the invention, not less original in its conception than benevolent in its object, of the Safety Lamp.

The great value of this contrivance, and of questions arising out of it, will I trust, be sufficient apology for diverging again from my story in order to mention some very important experiments now in progress by Mr. Galloway. Explosions, it is well known, occur even in cases where the safety lamp is used. And it has been noticed that in these cases they occur most frequently after the firing of a blasting shot in the neighbourhood; and as it was almost certain that the penetration of the fire-damp through the gauze of the lamp was not due to a sudden flow of gas from one part of the mine to another, experiments have been instituted to determine whether the transmission of the sound wave, or wave of compression, may not have been the means of producing the mischief. Through the kindness of Mr. Galloway we have here a tube arranged for making such an experiment. At one end there is the inflammable current burning outside a safety lamp; in the centre is an elastic diaphragm, and at the other end a pistol will be fired, by the explosion of which a sound wave will be propagated along the tube. On the arrival of the sound wave at the extremity of the tube, the combustion will penetrate the safety lamp. But I here leave the matter in the hands of Mr. Galloway, of whose experiments we hope to hear more hereafter.

(*To be continued.*)

PROFESSOR TYNDALL IN AMERICA

WHAT would the readers of any of our daily papers think, if they found half-a-dozen of its columns for six days on end, filled with verbatim reports of scientific lectures? Would not they be inclined to think their paper was in its dotage? But this has been done in the case of the *New York Tribune*, in whose columns, day after day, have appeared verbatim reports, with illustrations, of the six lectures which Prof. Tyndall delivered on Light in New York during the last days of last year? Not only has this been done, but the whole series of lectures has been issued on a separate sheet of four pages, each page as large as that of any of our daily papers, with twenty illustrations somewhat rude no doubt, but quite intelligible. This valuable sheet is sold at the astounding price of three cents, and as it has not a single advertisement, it must

have an immense circulation to be remunerative. Is not this one among many signs that the untrammelled Americans are rapidly outstripping us in the love for and the spread of scientific knowledge? It is certainly a noteworthy phenomenon which we wish could be witnessed nearer home. The editorial preface to the series concludes thus :—" If in the ulterior object of his (Professor Tyndall's) labours, the awakening of a spirit of scientific inquiry among our young thinkers, and the fostering of this tendency by liberal endowments from our wealthier citizens, his success shall be ultimately apparent, our whole country will have reason to thank the eminent Englishman." The following are a few passages from his concluding lecture :—

"It is never to be forgotten that not one of those great investigators, from Aristotle down to Stokes and Kirchhoff, had any practical end in view, according to the ordinary definition of the word 'practical.' They did not propose to themselves money as an end, and knowledge as a means of obtaining it. For the most part, they nobly reversed this process, made knowledge of their end, and such money as they possessed the means of obtaining it. We may see to-day the issues of their work in a thousand practical forms, and this may be thought sufficient to justify it, if not ennoble their efforts. But they did not work for such issues; their reward was of a totally different kind. In what way different? We love clothes, we love food, we love fine equipages, we love money, and any man who can point to these as the results of his efforts in life justifies these efforts before all the world. In America and England more especially he is a practical man. But I would appeal confidently to this assembly whether such things exhaust the demands of human nature? Given clothes, given food, given carriages, given money—is there no pleasure beyond what these can cover which the possessor of them would still covet? The very presence here for six inclement nights of this audience, embodying, I am told, to a great extent, the mental force and refinement of this city, is an answer to my question. I need not tell such an assembly that there are joys of the intellect as well as joys of the body, or that these pleasures of the spirit constituted the reward of our great investigators. Led on by the whisperings of natural truth, through pain and self-denial, they often pursued their work. With the ruling passion strong in death, some of them, when no longer able to hold a pen, dictated to their friends the results of their labours, and then rested from them for ever. . . . That scientific discovery may put not only dollars into the pockets of individuals, but millions into the exchequers of nations, the history of science amply proves; but the hope of its doing so is not the motive power of the investigator. It never can be his motive power.

"When analysed, what are industrial America and industrial England? If you can tolerate freedom of speech on my part, I will answer this question by an illustration. Strip a strong arm, and regard the knotted muscles when the hand is clinched and the arm bent. Is this exhibition of energy the work of the muscle alone? By no means. The muscle is the channel of an influence, without which it would be as powerless as a lump of plastic dough. It is the delicate unseen nerve that unlocks the power of the muscle. And without those filaments of genius which have been shot like nerves through the body of society by the original discoverers, industrial America and industrial England would, I fear, be very much in the condition of that plastic dough. At the present time there is a cry in England for technical education, and it is the expression of a true national want; but there is no outcry for original investigation. Still without this, as surely as the stream dwindles when the spring dries, so surely will their technical education lose all force of growth, all power of reproduction. Our great investigators have given us sufficient work for a time; but if their spirit die out, we shall find ourselves eventually in the condition of those Chinese mentioned by De Tocqueville, who, having forgotten the scientific origin of what they did, were at length compelled to copy without variation the inventions of an ancestry who, wiser than themselves, had drawn their inspiration direct from Nature.

"To keep society as regards science in healthy play, three classes of workers are necessary: Firstly, the investigator of natural truth, whose vocation it is to pursue that truth, and extend the field of discovery for the truth's own sake, and without any reference to practical ends. Secondly, the teacher of natural truth, whose vocation it is to give public diffusion to the knowledge already won by the discoverer. Thirdly, the applier of natural truth, whose vocation it is to make scientific knowledge available for the needs, comforts, and luxuries of life. These three classes ought to coexist, and interact upon each other. Now, the popular notion of science, both in this country and in England, often relates, not to science strictly so called, but to the applications of science. Such applications, especially on this continent, are so astounding—they spread themselves so largely and umbrageously before the public eye—as to shut out from view those workers who are engaged in the profounder business of discovery."

After quoting De Tocqueville on the supposed unfavourable influence which republicanism has on the advance of science, Prof. Tyndall says :—

"It rests with you to prove whether these things are necessarily so, whether the highest scientific genius cannot find in the midst of you a tranquil home. I should be loth to gainsay so keen an observer and so profound a critical writer, but, since my arrival in this country, I have been unable to see anything in the constitution of society to prevent any student with the root of the matter in him from bestowing the most steadfast devotion on pure science. If great scientific results are not achieved in America, it is not to the small agitations of society that I should be disposed to ascribe the defect, but to the fact that men among you who possess the genius for scientific inquiry are laden with duties of administration or tuition so heavy as to be utterly incompatible with the continuous or tranquil meditation which original investigation demands. I do not think this state of things likely to last. I have seen in America willingness on the part of individuals to devote their fortunes in the matter of education to the service of the commonwealth, for which I cannot find a parallel elsewhere.

"This willingness of private men to devote fortunes to public purposes requires but wise direction to enable you to render null and void the prediction of De Tocqueville. Your most difficult problem will be not to build institutions, but to make men; not to form the body, but to find the spiritual embers which shall kindle within that body a living soul. You have scientific genius among you; not sown broadcast, believe me, but still scattered here and there. Take all unnecessary impediments out of its way. You have asked me to give these lectures, and I cannot turn them to better account than by asking you in turn to remember that the lecturer is usually the distributor of intellectual wealth amassed by better men. It is not as lecturers, but as discoverers, that you ought to employ your highest men. Keep your sympathetic eye upon the originator of knowledge. Give him the freedom necessary for his researches, not overloading him either with the duties of tuition or of administration, not demanding from him so-called practical results—above all things, avoiding that question which ignorance so often addresses to genius: 'What is the use of your work?' Let him make truth his object, however impracticable for the time being, that truth may appear. If you cast your bread thus upon the waters, then be assured it will return to you, though it may be after many days."

ON THE SPECTROSCOPE AND ITS APPLICATIONS

III.

SO far, I have spoken of spectroscopes as spectroscopes —as one of the instruments the improvement of which should be cared for by every student in science. Their applications will come after. As may be imagined, spectroscopes are now constructed with one, two, three, four, or more prisms, the number depending on the purpose for which they are to be employed. An instrument with one prism is usually called a chemical spectroscope, for an instrument of this kind is now almost as important and essential in a chemical laboratory as a balance. Spectroscopes are also constructed with two prisms, as shown in Fig. 13; these are used in cases when rather more dispersion is desired than can be obtained with the one-prism instrument. When, however, any accurate and elaborate work has to be done, such as in carrying out original investigations, more prisms have to

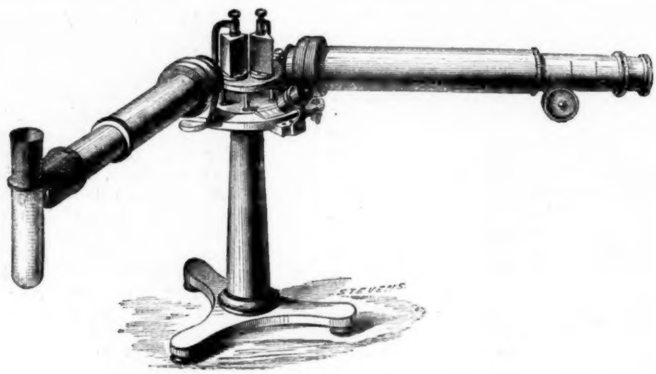

FIG. 13.—Spectroscope with two prisms.

be employed. The engraving given in Fig. 14 is of an instrument which historically is extremely interesting, as being the one with which Kirchhoff made his most elaborate and accurate maps of the solar spectrum; it is furnished with a battery of four large prisms, which give an enormous deviation and dispersion. There is no reason

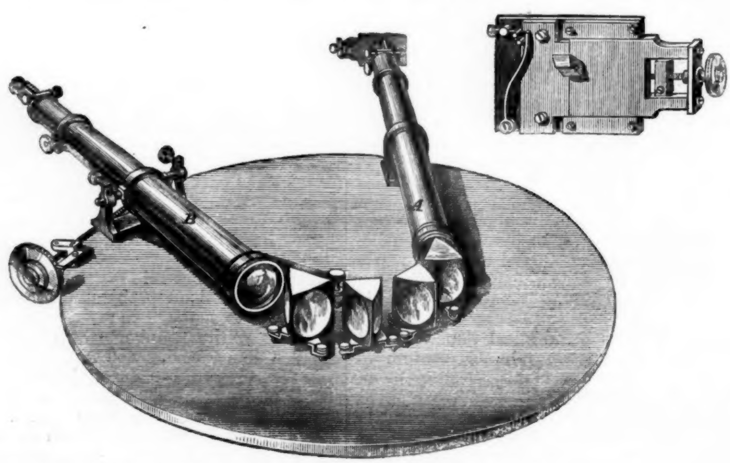

FIG. 14.—Steinheil's form of four-prism spectroscope; arrangement of slit shown separately.

why spectroscopes of many more prisms should not be employed, except that they require to be worked only with strong lights, as light is here so much dispersed or spread out that a feeble spectrum would be almost lost. As the principle of construction is almost the same in all kinds of spectroscopes, we had better commence by a description of the simplest form, namely, that with one prism, as shown in Fig. 15. It will be seen to consist of a circular table, supported by a pillar and three legs, carrying three lateral tubes; the right-hand tube is called the collimator, and holds at its outer extremity the fine slit, the width of which can be regulated to a nicety by a micrometer screw; the other end of the collimator is furnished with a lens, which serves to collect the rays of light coming from the slit, and to render them parallel before falling on the prism in the centre of the table. The prism is so placed and fixed by a clamp that the light entering the slit from the source of light, shown in the figure as a gas lamp, strikes it and leaves it at what is called the *angle of minimum deviation*, a term which has already been explained; after passing through the prism, in which the light undergoes both deviation and dis-

persion, the spectrum is observed by the telescope on the left, which is simply a small astronomical telescope of low magnifying power. There are two methods of measuring spectra. The telescope may be attached to a moveable arm, which can be directed to any part of the spectrum that may be required; and the outer edge of the circle along which the telescope moves may be graduated with an accurate scale of degrees, which can be divided

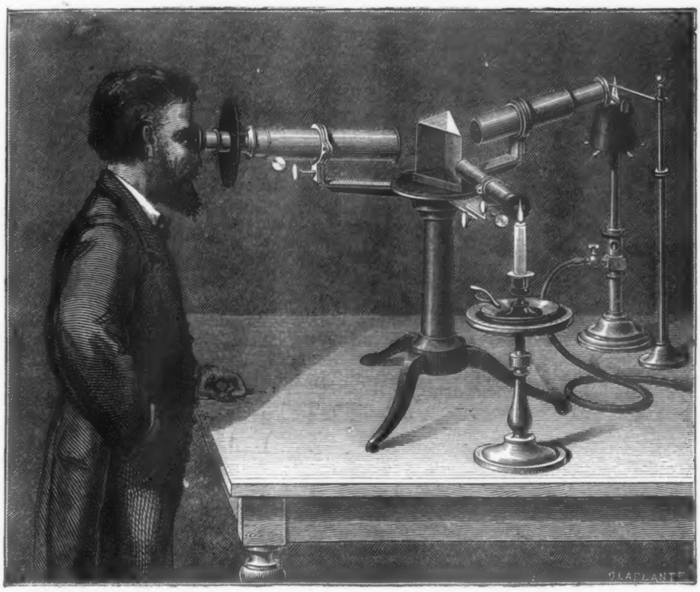

FIG. 15.—Spectroscope with reflected scale.

with more or less minuteness, according to the precision in the exact position of the dark lines, &c., in various spectra required. In this method the line to be measured is brought into the centre of the field of view of the observing telescope, and the position of the telescope read off. Of course if the line measured is situated in the red end of the spectrum, the telescope will be in a different position to that it will occupy if the line be in the blue end. The

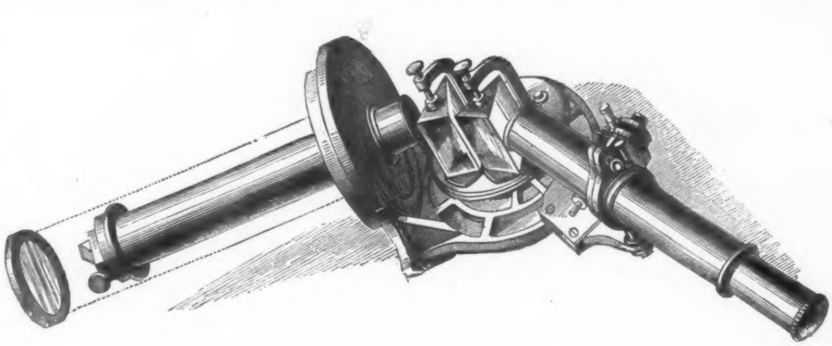

FIG. 16.—Huggins' star spectroscope.

second method of measurement may be gathered from Fig. 15. It consists of a short tube carrying at its outer extremity a small photographic scale, which is illuminated by a candle flame; the light passing from the photographic scale is rendered parallel and thrown on the surface of the prism by means of a lens in the tube carrying the scale, and is reflected by the last surface of the prism up the observing telescope, so that it is seen as a bright scale on the background, formed by the spectrum under observation.

The spectroscope has also been adapted to the telescope with very great success; for it is essential not only to determine the spectra of the light emitted by various substances in our laboratories on this earth, but also the different spectra and positions of the dark lines or bright ones, &c., obtained from the various orders of celestial

objects, such as the sun and stars, comets, nebulæ, planets, and so on; we must for this purpose have something attached to the telescope. Fig. 16 shows a star spectroscope, which differs in arrangement only and not in principle from other spectroscopes, except in one point to which I have to draw attention with regard to this spectroscope. I have insisted on the importance of the slit; but you will see in a moment that the image of a star, if it is a good image, will be a mere point in the telescope, and therefore, while

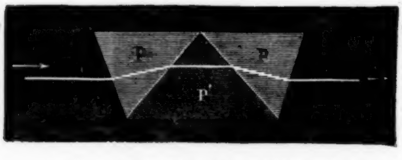

FIG. 17.—Direct-vision prism with three prisms.

a slit is not absolutely necessary, it is essential to have some arrangement by which that point of light, the spectrum of which would be merely a line, and therefore not broad enough to enable us to see what the lines are which we may expect in the spectra of stars, if they be anything like the spectrum of the sun, shall be turned into a band. That has been accomplished by means of a cylindrical lens, its function being to leave the light alone in one direction, but to turn it into a band in another direction, so that when the light of the star gets through such a lens, it is no longer a point but a line, and this is then grasped by the collimating lens, sent through the prisms, and received by the observing telescope, so that when you get the image of it in the observing telescope, instead of having a line of light so fine that the lines in it cannot be distinguished, it is a distinctly broad band in which the lines can be observed. As this lens is simply a contrivance for enabling the eye to see about where there is a line, I submit now, as I submitted some years ago, that a proper place for it is close to the eye, between the eye and the image. I have been gratified to find that, in many of the spectroscopes used on the Continent, this arrangement is adopted.

We have now an idea of the action of the simple prism. I will next bring to your notice another kind of prism, which differs from the simple one very much as the achromatic telescope differs from the non-achromatic one, which was the first attempt made at an instrument for astronomical observations. Many of you know that the object-glass of a telescope, as now constructed, consists of two lenses made of different kinds of glass. Of course, we have dispersion and deviation at work in both these kinds of glass, but the lenses are so arranged, and their curves are so chosen, that, as a total result, the deviation is kept while the dispersion is eliminated, so that, in the telescope, we have a nearly white image of anything which

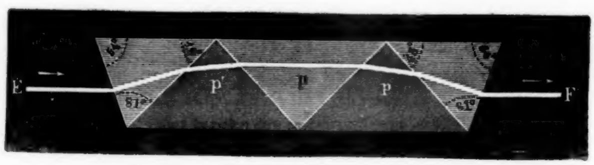

FIG. 18.—Direct-vision prism with five prisms.

gives us ordinary light, although, as you know, it is by the deviation alone that we are enabled to get the magnified image of that object. So also in the spectroscope we have an opportunity of varying the deviation and the dispersion. By a converse arrangement we can keep the dispersion while we lose the deviation; in other words, we have what is called a direct-vision spectroscope. If we take one composed of two prisms of one kind of glass which possesses a considerable refractive power, and three prisms of another kind which does not refract so strongly, arranged with their bases the opposite way, the deviation caused by the two prisms in the one direction will be neutralised by the deviation of the three prisms in the opposite direction; whilst the dispersion by the three prisms, exceeds that which is caused by the two prisms in the opposite direction, the latter dispersion therefore will neutralise a portion only of the dispersion due to the three prisms. The final result is that there is an outstanding dispersion after the deviation has been neutralised, so that when we want to examine the spectrum of an object we no longer have to look at it at an angle. No doubt you recollect the angle that was made by the light the moment it left the prism, but we have an opportunity, by this arrangement, of seeing the spectrum of an object by looking straight at the source of light: in the application of spectrum analysis, especially to the microscope and telescope, this modification—due to M. Janssen, the well-known astronomer, who was the first to bring it into general notice—is one of great practical importance, so that in any research which does not require excessive dispersion, this direct-vision arrangement is getting into common use. I have here another direct-vision arrangement which is well worthy of being brought to your notice. It does not depend at all upon the principles I have just been trying to explain to you. It is called the Herschel-Browning direct-vision spectroscope, in which the ray is refracted and reflected internally, in the prisms themselves. We have therefore, in addition to the simple prism which I formerly brought to your attention, two other aids to research of extreme value in certain classes of observations. The direct-vision spectroscopes which are now sold are made on one of the two principles just described; some of them are made so small that they can be easily carried in the waistcoat-pocket, and still are so powerful that all the principal, and many of the less prominent, lines in the solar spectrum may be seen with them.

Of the special application of the spectroscope to the microscope I need say but little now. The spectroscope thus used is a direct-vision one, this form being far more convenient for attaching to the microscope. The light which illuminated the object in the microscope was first of all passed through a prism; but in later arrangements it passes through the prism in its passage from the object. This is obviously a much better plan, because, in the first instance, you could only deal with transparent objects; but here, as you deal in any case with the light that comes from the object itself, it is quite immaterial whether the object be opaque or transparent.

J. NORMAN LOCKYER

(*To be continued.*)

SCHOLARSHIPS AND EXAMINATIONS FOR NATURAL SCIENCE AT CAMBRIDGE, 1873

THE following is a list of the Scholarships and Exhibitions for proficiency in Natural Science to be offered at the several Colleges in Cambridge during the present year :—

TRINITY COLLEGE.—One or two of the value of about 80*l.* per annum. The examination will be on April 5, and will be open to all Undergraduates of Cambridge and Oxford, and to persons under twenty who are not members of the Universities. Further information may be obtained from the Rev. E. Blore, Tutor of Trinity College.

ST. JOHN'S COLLEGE.—One of the value of 50*l.* per annum. The examination (in Chemistry, Physics, and Physiology, with Geology, Anatomy, and Botany) will be in December, and will be open to all persons who have not entered at the University, as well as to all who have entered and have not completed one term of residence. Natural Science is made one of the subjects of the annual college examination of its students at the end of the academical year, in May; and exhibitions and foundation scholarships will be awarded to students who show an amount of knowledge equivalent to that which in classics or mathematics usually gains an exhibition or scholarship in the college. In short Natural Science is on the same footing with Classics and Mathematics, both as regards teaching and rewards.

CHRIST'S COLLEGE.—One or more, in value from 30*l.* to 70*l.* according to the number and merits of the candidates, tenable for three-and-a-half years, and for three years longer by those who reside during that period at the College. The examination will be on April 1, and will be open to the undergraduates of the College; to non-collegiate undergraduates of Cambridge; to all undergraduates of Oxford; and to any students who are not members of either University. The candidates may select their own subjects for examination. There are other Exhibitions which are distributed annually among the most deserving students of the College. Further information may be obtained from John Peile, Esq., Tutor of the College.

CAIUS COLLEGE.—One of the value of 60*l.* per annum. The examination will be on April 1, in Chemistry and Experimental Physics, Zoology, with Comparative Anatomy, Physiology, and Botany, with Vegetable Anatomy and Physiology; it will be open to students who have not commenced residence in the University. There is no limitation as to age.—Scholarships of the value of 20*l.* each, or more if the candidates are unusually good, are offered, for Anatomy and Physiology, to members of the college.—Gentlemen elected to the Tancred Medical Studentships are required to enter at this College; these Studentships are four in number, and the annual value of each is 113*l.* Information respecting these may be obtained from B. J. L. Frere, Esq., 28, Lincoln's Inn Fields, London.

CLARE COLLEGE.—One of the value of 50*l.* per annum, tenable for 3½ years. The examination (in Chemistry, Chemical Physics, Comparative Anatomy, and Physiology, and Geology) will be on March 26, and will be open to students intending to begin residence in October.

DOWNING COLLEGE.—One or more of the value of 40*l.* per annum. The examination (in Chemistry, Comparative Anatomy, and Physiology) will be early in April, and will be open to all students not members of the University, as well as all undergraduates in their first term.

SIDNEY COLLEGE.—Two of the value of 40*l.* per annum. The examination (in Heat, Electricity, Chemistry, Geology, Zoology and Physiology, and Botany), will be on April 1, and will be open to all students who intend to commence residence in October.

EMMANUEL COLLEGE.—One or more of the value of 50*l.* tenable for two years. The examination on April 1 will be open to students who have not commenced residence.

PEMBROKE COLLEGE.—One or more of the value of 20*l.* to 60*l.* according to merit. The examination (in June, in Chemistry, Physics, and other subjects) will be open to students under twenty years of age.

ST. PETER'S COLLEGE.—One from 50*l.* to 80*l.* per annum, according to merit. The examination, date not yet fixed, in Chemistry, Comparative Anatomy and Physiology, and Botany, will be open to students who will be under twenty-one years of age on October 1, 1873, and who have not commenced residence.

KING'S COLLEGE.—One of the value of about 80*l.* per annum. The examination, on April 21, will be open to all candidates under twenty, and to undergraduates of the College in their first and second year. There will be an examination in elementary classics and mathematics, in addition to three or more papers in Natural Science, including Physics, Chemistry, and Physiology.

Although several subjects for examination are in each instance given, this is rather to afford the option of one or more to the candidates than to induce them to present a superficial knowledge of several. Indeed, it is expressly stated by some of the colleges that good clear knowledge of one or two subjects will be more esteemed than a general knowledge of several.

Candidates, especially those who are not members of the University, will, in most instances, be required to show a fair knowledge of classics and mathematics, such, for example, as would enable them to pass the previous Examination.

There is no restriction on the ground of religious denomination in the case of these or of any of the Scholarships or Exhibitions in the colleges or in the University.

Further information may be obtained from the Tutors of the respective Colleges.

It may be added that Trinity College will give a Fellowship for Natural Science once, at least, in three years: and that most of the Colleges are understood to be willing to award Fellowships for merit in Natural Science equivalent to that for which they are in the habit of giving them for Classics and Mathematics.

NOTES ON ZOOLOGY AND BOTANY IN LISBON

LISBON possesses a remarkable natural history collection which is at present in process of transference to the new Polytechnic School buildings, which are only just completed. This institution is of imposing dimensions, built in the form of a square, with a quadrangular garden in the centre, and contain spacious and well-lighted laboratories, lecture rooms, and galleries for museum purposes. On the ground floor is a mineralogical and palæontological collection, and over this is the natural history series, which is contained in four fine rooms, one of which is devoted entirely to the African fauna, in which the museum is particularly rich. In all the rooms table cases are placed down the central line containing the collection of shells, which is very fine and well arranged, whilst upright cases are ranged along the walls and are filled with stuffed Mammalia, and birds, and variously preserved reptiles and fish. Amongst the Mammalia are two manatees, a fine specimen of the Aye-Aye, *Cheiromys*, and also one of the curious little otter-like animals from Africa, *Potamogale velox*, which has its tail flattened out into a vertical rudder. These are mentioned as rarities. The series is large and especially good in insectivora, moles, shrews, &c.

The birds are quite remarkable for the excellence of their preservation, and as the series is very extensive, it forms the chief feature of the collection. There are a large

number of rarities, amongst which may be mentioned a perfect specimen of the great auk, *Alca impennis*, in excellent plumage and preservation, *Didunculus strigirostris*, and a fine series of Birds of Paradise, including *Semiopteryx*.

Amongst the reptiles are large specimens of *Alligator nigra*, and a large number of *Chelonia*, and amongst the fish a fine series of *Selachians*. There is also a collection of the skeletons of vertebrata, and a large number of Invertebrata, corals, sponges, starfish, &c.; but this part of the collection is not yet arranged in the new building. The natural history department is under the direction of Prof. Barboyo du Bocage, who, it will be remembered, first described the siliceous sponge, *Hyalonema*, from Setubal Bay and on the Portuguese coast.

About a mile and a half or two miles from the heart of the city of Lisbon on high ground is the Botanical garden. The garden consists of two terraces, one above the other. The lower terrace contains nothing remarkable except a group of date palms, *Phœnix dactylifera*, one of which is about 45 ft. high, which are now in various stages of flower and fruit. On the upper terrace are two glass houses, but in bad repair and apparently not containing anything remarkable. But growing in the open air is a splendid specimen of the dragon tree, *Dracœna draco*, with a perfectly circular head of foliage, which must be 36 yards at least in circumference, whilst the stem is about 16 feet in circumference. The tree was covered with the dried remains of its fruit. *Aloe arborescens* is plentiful in the garden and indeed all over Lisbon, and is now in flower. Also growing in the open air are *Musa paradisiaia*, *Ficus elastica*, *Euphorbia veriifolia*. There is a nice series of plants classified according to their natural orders, the aloes and cactuses being well represented; but the whole garden has been allowed to fall into neglect, and presents a dreary appearance, being overrun by weeds, and most of the beds are nearly choked. It is intended to abandon the garden as a botanical one, and remove as many plants as possible to the garden attached to the new Polytechnic school, but it is to be hoped that the *Dracœna* will not be neglected. The flora generally which one meets with in Lisbon is most remarkable; Australian and Brazilian acacias abound in all the gardens, and thrive and become large trees. There is quite a rage for Eucalypti, which are said to grow as much as 14 feet in height here in a single year. They are to be seen everywhere, and some species are at present in blossom. At Embia, in the neighbourhood, tree ferns grow in the open air, and in the grounds of the King's palace besides *Chamærops* and *Phœnix dactylifera*, which are common in gardens about the town, *Jubœa spectabilis* and the Seychelle double cocoa-nut palm, *Lodoicea*.

H. N. MOSELEY

NOTES

MR. COLE, we regret very much to say, after fifty years public service, has announced his intention of resigning his post in connection with the Science and Art Department. It would be difficult indeed to estimate the extent and value of the services performed by Mr. Cole in behalf of science, services which have hitherto been most inadequately recognised, though we are certain this will not now be long the case. He has done more than any other man in the kingdom to establish schools of science throughout the country and to foster scientific instruction in every way, and that, too, in the face of opposition from quarters from which it would have been little expected.

PROF. SYLVESTER, late of the Royal Military Academy, Woolwich, has been elected a corresponding member of the Imperial Academy of Sciences of St. Petersburg.

WE have with great pleasure recorded from time to time the encouragement given to the study of Natural Science in our Universities and public schools, and are glad in reporting progress to notice that the governors of the Giggleswick Grammar School are carrying out the spirit of recent legislation in providing for the wider education which the age has called for. Giggleswick is an ancient village close to which, on the opposite side of the river Ribble, the more modern town of Settle has sprung up. Situated at the foot of the mountainous moorlands of north-west Yorkshire, where the Ribble quits its rocky gorges to wander over a wide rich valley, where peaty flats represent ancient lakes, this has long been known as a most interesting spot by the naturalist and antiquary. It was fortunate therefore for the cause of Natural Science, that the existence of an old well-endowed institution induced the Commissioners to fix upon Giggleswick as the chief school of a large district in the north of England, embracing some of the most important towns in Yorkshire. It so happens that in the immediate neighbourhood there are several very interesting caves, the exploration of which is being carried on by a Committee, amongst whom are many of our leading men of Science. The Committee have handed over the whole of the valuable remains obtained from the caves to the governors of the school, on the understanding that they will provide for their safe keeping and exhibition to the public. The Council of the Leeds Philosophical Society have followed up this by promising a very large series of duplicates from their museum, and the able curator of the Leeds Museum has undertaken to assist in the arrangement and classification of the collection. It is the duty of all scientific men to watch and encourage all *bonâ fide* efforts to give a prominent place to the teaching of Natural Science in our schools, especially where, as in this case, it is combined with a movement to form a scientific centre where illustrative specimens may be examined; and it is to be hoped that by-and-by all the standard works on scientific subjects may be consulted by a wide circle outside the school. The names of Sir James Shuttleworth, one of the governors of the school, and of Sir Charles Lyell among the supporters of the movement, offer a sufficient guarantee as to its character.

THE following extracts from a letter of Mr. Alexander Agassiz will be read with interest. It will be seen from them that the great fire at Boston did not spare the labours of scientific workers. The passage which refers to the health of his father, Prof. L. Agassiz, will give especial satisfaction to every naturalist on this side of the Atlantic:—"I am just in the middle of my Echini. I have had a very narrow escape with my book. The great fire, which has destroyed half Boston, came near to putting a stopper on my work. The plates of nearly one-third of the whole edition have not been printed, as the stones were lost in the fire. Fortunately I had about three hundred copies of the plates of parts I. and II. at the Museum out of the way, so must manage as best I can with that number. I lost, in addition, the stones of six plates of anatomy, with all the original drawings, which had been sent to the lithographer for lettering the plates. This is more serious, as it represents over a year's hard work, and the bulk of the notes being on the back of the drawings, it will delay the publication of my book for a good while. Parts I. and II. are at last out. My father has returned from his long trip a much better man than when he left, and it looks as if he would do a good amount of work yet. He has not been in such excellent health for many years."

THE increasing use of scientific terms in popular literature may be a good sign, but such terms have now and then to do unwonted duty. Witness a passage from a new tale entitled "Little Hodge," by the author of "Ginx's Baby." It is out of a pathetic description of a very small new-born child being weighed in the workhouse. "'Poor little creetur!' said the

nurse, taking up the morsel of humanity from its uncomfortable position in the workhouse scales, which had been brought up from the kitchen expressly to test its *specific gravity*." We hasten to add that we infer from this a slight confusion in the author's mind, not an accusation against our workhouse officials of weighing new-born babies under water for experimental purposes.

WE understand that the Fellows of the Chemical Society have started a Chemical Club, one of the objects of which is to promote the contribution and discussion of original papers to the society, and to encourage good fellowship amongst its members. The number of members is limited to fifty, and we hear that there are only a few vacancies remaining. The meetings of the club take place once a month, when the members dine together before adjourning to the evening meeting of the Chemical Society.

WE are glad to notice the formation of a society at New Cross, entitled "The New Cross Microscopical and Natural History Society," which meets at the Commercial Rooms, Lewisham High Road. The society has, we believe, made a good start, and will be glad to receive additions to its membership, and we hope that all who join it will remember that the best way to ensure success for such a society is by every member striving to take a share in the work. By means of exhibitions, the formation of natural history cabinets, microscopical work, excursions, lectures and papers, the society seeks to carry out its objects. The subscription is small, only ten shillings a year. Further information may be obtained from the hon. sec., Mr. Martin Burgess.

THE sixth annual Soiree of the Old Change Microscopical Society will be held at the City Terminus Hotel, Cannon Street, on Friday evening, February 28.

THE *Challenger* arrived at Gibraltar on Saturday, and is expected to leave to-day for Madeira.

MR. PRESCOTT HEWETT has been elected President of the Clinical Society of London, in succession to Sir William Gull.

SIR JOHN C. BURROWS, F.R.C.S., Mayor of Brighton, who gave such a splendid reception to the British Association last year, has just received the honour of knighthood.

LORD NEAVES is to be formally installed as Lord-Rector of the University of St. Andrews, on February 13. We understand Lord Neaves is to offer four prizes annually during his term of office, to be competed for by students attending the University.

WE announced last week that Mr. W. Saville Kent has been appointed resident naturalist and curator of the Brighton Aquarium, in room of the late Mr. J. K. Lord. We believe Mr. Kent is to have the assistance, as consulting naturalists, of Messrs. Henry Lee and Frank Buckland, while Mr. Reeves Smith, late of the Spa at Scarborough, has been engaged as general manager and secretary. Under Mr. Lee's advice and superintendence important changes and improvements are already being effected. Fishes of incongruous species, which have lately had joint possession of some of the tanks, are being separated and placed in those best suited to their habits; whereas only six tanks have hitherto been set apart for the exhibition of fresh water fishes, eight additional ones have now been prepared for them, which can be reconverted into receptacles for marine specimens in a few hours in case of need. Tanks for the storage of a reserve of specimens apart from public view are in course of construction, and arrangements are being made for careful observation of the marine invertebrata and other forms of aquatic life. It has also been proposed that a series of microscopes shall be provided, by means of which interesting living and mounted objects, illustrative of the minute organisms developed in the tanks shall be exhibited to the public. This indicates a serious intention to utilise the great resources of the Brighton Aquarium, as they should be utilised for the purposes of experimental and practical zoology, by affording opportunity for careful researches and investigations which may prove of scientific interest and economic value.

WE have received a copy of the *Mobile Register* for December 15 last, containing a letter from Mr. A. W. Dillard, in which he endeavours to account for the generally acknowledged increase in the severity of the winters in Alabama. In all European countries it is commonly believed the climate has become warmer in proportion as the forests have been felled and the land cultivated. In Alabama, however, similar operations have apperently produced opposite results. The writer, however, believes that the general dryness of Africa, and especially of the Great Desert, has no inconsiderable effect on the climate of Europe, and accounts for the great difference of temperature between the same latitudes in Europe and America. He accounts for the change of climate in Alabama and other southern American states in the following way:—"The felling of our Southern forests gives a more unrestricted scope to the northwestern winds, chilled by the snow on the Rocky Mountains and the ice of the northern lakes and rivers. These bleak winds are not counteracted by warm gales, blowing from a dry country, such as Africa; consequently they exert all their chilling influence on our climate. The gales which we have from the south are impregnated with a good degree of moisture, and so add to the cold consequent upon the blowing of the wind from the north."

A DESPATCH from Dr. Kirk, dated Zanzibar, Nov. 5, 1872, has been received at the Foreign Office. It announces that the men sent to help Dr. Livingstone had reached him, and that he had started for the interior about August 18.

IN NATURE, vol. vii. p. 7, we intimated that among other expeditions to the Arctic Regions was one under the command of a rich and adventurous young Frenchman, M. Pavy, that had set out from San Francisco to go by way of Wrangell Land, to the north of the eastern part of Siberia. If we can trust a report in the *Times* for January 17 from the *Courier des Etats Unis*, his hopes have been gloriously realised, for he has discovered an Arctic Continent. The account professes to be a summary of despatches, dated Wrangell Land, lat. 74·38, W. long. 176·18, August 23, 1872, committed to the care of the captain of a whaler, for the French Geographical Society, which, it is said, will publish the scientific results after having examined them. A similar account appeared some time since in the *Scotsman*. The following are the chief points of the somewhat remarkable story:—On July 17 Pavy and his party reached the mouth of the river Petrolitz. From this point they met with immense fields of ice moving towards the north-east. The observations indicated a deviation of 18 miles, caused by the movements of the ice, a fact tending to confirm the theory of M. Pavy respecting the concentration and the augmentation in rapidity of the branch of the great Japanese current, called Ku-Ro-Sirod, which passes through Behring Strait, and flows toward the east away from the coast of Siberia. The exploring party reached the coast of Wrangell Land, at the mouth of a great river coming from the north-west, which is not laid down on any map. This discovery confirms M. Pavy's theory that there exists a vast polar continent which stretches far to the north, the temperature of which is warm enough to melt snow in summer. The current of this unnamed river turns to the east, and follows the coast with a velocity of six knots an hour. M. Pavy and his companions followed the current of the river towards the north, a distance of 230 miles. Its bed is uniformly horizontal, and it is bordered by mountains of great height, with several perpendicular

peaks. At 80 miles from the mouth the explorers found on the plain some vestiges of mastodons, and on clearing away the snow from a spot whence emerged the tusks of one of that extinct race, they brought to light its enormous body, in a perfect state of preservation. The skin was covered with black stiff hair very long and thick upon the back. The tusks measured 11 ft. 8 in. in length, and were bent back about the level of the eyes. From its stomach were taken pieces of bark and grasses, the nature of which could not be analysed on the spot. Over an area of many miles the plain was covered with the remains of mastodons. This region abounds with polar bears, which live on the remains of the mastodons. At 120 miles from the coast and half a league from the river, rises a vast block of ice 1,000 ft. high, the base of which is surrounded by gravel and polished rounded stones deeply sunk in the soil. The Arctic animals are very numerous in this valley, and myriads of birds fly above the river and over both of its banks. At the date of his despatches M. Pavy was preparing to winter in the 75th degree of latitude in the valley of the great river of the supposed polar continent. He considered himself certain to arrive in the beginning of next season at a polar sea of moderate temperature at the northern extremity of the continent. The explorers calculate on afterwards reaching the Atlantic through Melville Strait.

THE two principal articles in the last number of the *Bulletin de la Société de Géographie* are, one by M. Jules Gerard, on the present state of knowledge of New Guinea, in which he gives a historical account of discovery in that island, and a description of its geography, ethnography, natural history, meteorology, its colonisation and commercial relations. This is accompanied by a good map. The other is an account of the river Amazon, and the region through which it flows, by the Abbé Durand, compiled from various geographical memoirs. The same number contains a letter from the Abbé Desgodins, pointing out, apparently from personal knowledge of the region concerned, a number of errors in Mr. T. T. Cooper's "Travels of a Pioneer of Commerce."

WE have received the programme of "The Leeds Naturalists' Field Club and Scientific Association," for the next three months. It meets every Tuesday evening, alternate meetings being devoted to the reading of papers and to the exhibition of specimens, with general discussion on scientific subjects. During the first three months of 1873 the following papers will be read:—Rev. John Hanson on "The Development or Transformation of Insects." Mr. James Abbott, vice-president, on "The Anatomy of the Slug." Mr. Geo. Ward, F.C.S., "Observations upon the Element Carbon." Mr. Edwin Birchall, on "The Origin and Distribution of the Insects of the British Islands." Mr. Wm. Todd, vice-president, on "The Silurian Rocks and Fossils." The annual meeting will be held on March 25.

THE last number of *Memorie della Società degli Spettroscopisti Italiani*, contains drawings of the chromosphere as observed at Rome, Naples, and Padua during January, February, and March 1872.

THE first number of *Iron*, the name of the new series of the *Mechanic's Magazine*, is printed on a very much larger size of paper than its predecessor, and contains a number of useful articles, mostly on the practical applications of scientific principles. We wish *Iron* a long and successful career.

THE principal paper in the *Revue Scientifique* for January 18, is a continuation of the article on "The Observatories of Great Britain," in which details are given concerning the Observatories at Edinburgh, Dublin, the Cape of Good Hope, Madras, Melbourne, Paramatta (New South Wales), Sydney, and Lucknow.

WE learn from the *Medical Record* that a new faculty of medicine is about to be instituted at Geneva.

THE STAR SHOWER AS SEEN AT MAURITIUS

A GREAT shower of meteors was observed in this colony on the night of November 27 last. I had not myself the good fortune to see it, but it was seen by several other persons who have obligingly communicated their observations.

At the Observatory it is customary to watch, as far as possible, for meteors during the whole of November, but, on the night in question, the sky was nearly overcast. At 9.15 P.M. we had a shower of rain, and at 9.30, when the last observation of the instruments and of the weather was taken for the night, nine-tenths of the sky were overcast, and the weather was gloomy. Looking out about midnight from a window facing the north I observed that the visible parts of the heavens was still overcast, but remarked that the clouds were unusually luminous, as if the moon in her first or last quarter were shining behind them. This struck me particularly, and I waited some minutes in expectation of seeing a break in the clouds.

On the following day, I received a telegram from the Hon. Edward Newton, Colonial Secretary, announcing that he and Mr. C. Bruce, Rector of the Royal College, had counted from their residence, twelve miles off, and nearly 900 feet above the sea-level, 2,678 meteors between 9.30 P.M. and 12.55 A.M.; and soon afterwards I ascertained that some other members of our Meteorological Society, as well as several other gentlemen, had also observed the shower, all from the same part of the Island.

In place of attempting to summarise the accounts which have reached me, I think it preferable to give them in full, in the order in which they were received.

(1.) *Observations by the Hon. Mr. Newton and Mr. Bruce.*—"About 9.30 on the evening of November 27 we observed an unusual frequency of shooting stars. At 9.35 we began to keep regular count. We continued our observations till 12.55, at which time the frequency had greatly diminished, as will be seen from the following statement of the numbers seen in the intervals of time noted—

From 9.35 to 10.35	786
" 10.35 " 11.35	1,160
" 11.35 " 12.10	454
" 12.10 " 12.35	193
" 12.35 " 12.55	85
Total	2,678

"The approximate time of greatest intensity of the shower was from 11 to 11.30. About this time two meteors of extraordinary brilliancy were particularly noted: the first at 11.22, and the second at 11.44.

"The former of these started from the three stars in the tail of Aries, and the luminous orb vanished somewhat south of the Ecliptic. The train of this meteor was distinctly visible for 4 minutes. At the vanishing moment of the luminous point, it slowly wheeled from horizontal to vertical, and was seen for nearly two minutes vertical to the horizon.

"The latter, starting from a point at right angles to the three stars in the tail of Aries and the Pleiades, passed through the Pleiades, Taurus, and Orion, and vanished near Sirius. Its train was visible for more than a minute.

"Nearly all the meteors observed radiated from a point near Aries, nearly at right angles with the Pleiades, and shot either in the direction of the bright meteor of 11.44, or in a line through Aries, cutting the ecliptic and vanishing to the S.

"From eighty to ninety per cent. of the meteors were followed by a soft, broad train of light, visible for a few seconds after the vanishing of the luminous point, of diameter at least equal to the luminous orb, and extending from 10° to 20°. In the case of the two bright meteors above mentioned, the train of light extended over at least 40°.

"During our observations, portions of the heavens were from time to time obscured by dark fleeting clouds, which at times obscured the starting and vanishing points.

"Between 10 and 11 we observed occasionally a pulsating coruscation, similar to the appearance of the Aurora Australis. Mr. Meldrum, however, informs us that the instruments at the observatory gave no indication of a magnetic disturbance.

"In colour the majority of the meteors seemed to be equal in purity to that of the most colourless stars.

"Taking a point as above described as visible radiating point, the angle of the majority of the meteors was about equal to that of the meteors figured in 'Johnston's Astronomical Atlas,' seen in November 1866.

"A few however, shot with extreme velocity towards the north; these had no trains of light; other meteors shot parallel to the general direction close to the horizon. Although we discontinued our observations at 12·55, the shower was not over, and a few meteors were seen near the western horizon after this time.

"It must be observed that the point from which our observations were taken was obscured by trees in the directions of the western horizon. About the time of greatest intensity, nine meteors were visible at the same moment.

"During the greater part of our observations, up to midnight, the radiation of these four or five meteors was nearly synchronous.

"Towards the time of the greatest intensity, one of the observers was absent for about fifteen minutes, and it is probable that many meteors during this interval escaped observation."

(2). *Observations by Lieut.-Colonel O'Brien, Inspector-General of Police, and Mr. A. Brown.*—"At about 10 o'clock last night (Nov. 27) our attention was drawn to the number of falling stars. Going outside and standing back to back, Mr. A. Brown and myself in a short time counted no less than 110. This continued till near 11 P.M., when we went out again, and in five minutes counted 118. Some of these meteors were very bright, having tails like comets. Their course was generally longer than that of the others, and they seemed nearer to the earth. The course of the shower was almost invariably from north to south, and more meteors were visible towards the southern hemisphere than in other quarters."

(3). *Observations by the Hon. Robert Stein and Mr. A. C. Macpherson.*—"On November 27, about 10·15 P.M., on looking towards the N.E. we noticed several meteors falling; the Pleiades, Hyades, and Orion being at that time about 45° to 50° above the horizon.

"On observing carefully, we found the meteors in great numbers coming from due north very much on a level with the stars above mentioned, and rather farther to the north of the Pleiades than the distance between the Pleiades and Hyades.

"They came not from a point, but as it were along a broad belt crossing the sun's path nearly at right angles, appearing at times in the north, but often also at the zenith and towards the southern horizon, passing as it were parallel, some from N.E. to S.E., some from north to south, and some from N.W. to S.W.

"The number of meteors was so great, and they appeared so irregularly, sometimes towards the north, sometimes overhead, sometimes to right or left of the zenith, and sometimes towards the southern horizon, that we could not keep count of them; but from 10.15 to 10.30 they appeared to be falling at about the rate of one in every second, sometimes singly, and sometimes in twos or threes at a time. The more distant ones showed only bright luminous points, but the nearer ones every few minutes showed trains and sparks like a rocket, varying from 2° or 3° to 5° or 6° in length, and seldom reaching a length of 10°.

"Our view to the S.W. was partly closed, but on changing position, so as to get a view of that quarter, I found the meteors falling there too; but it appears to me during the short time I looked in that direction, towards eleven o'clock, as if fewer were falling there than I had observed to the eastward of south."

(4.) *Observations by Mr. W. H. Marsh, Assistant Colonial Secretary.*—"I observed the shooting stars at first at 9 o'clock. The sky was cloudy, but in spaces that were occasionally left clear, the meteors could be seen going from north to south. About half an hour later the sky was quite clear. I counted 100 shooting stars in less than five minutes. With the exception of one in Andromeda, which went in an easterly direction, they all went to the south. I continued observing till 10.30. The meteors were almost entirely confined to the western half of the heavens, and by far the greater number was observed in Aquarius and in the neighbourhood of Fomalhaut. Most of them were very dim and small, but occasionally a bright one made its appearance. I observed a very bright one at about 10·15, which came from the direction of the zenith, and appeared to pass right through the Star Achernar."

Observations by Capt. Fry.—"On the evening of November 27 my attention was drawn towards the heavens by seeing an immense number of stars of all magnitudes shooting towards the south from Orion, which was at the time about 30° above the eastern horizon, in a straight line through the zenith to about 40° above the western horizon, below which altitude clouds obscured the sky. The greater number seemed to move from the southern side of the above described line. They were all exceedingly bright, and varied in size from an ordinary meteor to *infinitely* small. The time was from 9 to 10.15 P.M., when clouds screened the view. I endeavoured to keep count, but could not, owing to the immense number and the quickness of their movements. I am an old mariner, and have often had opportunities of watching the heavens at night, but I never witnessed anything to compare to the sight on the night of the above date. On the 28th I made preparations to watch for a repetition of the spectacle; but not having seen more than is observed on an ordinary night, say four or five, I gave it up, and retired at 11 P.M."

Observations by Capt. Gaston, of the Ship "Pénélope," from Vohemar to Mauritius.—"Le Mercredi, 27 Novembre, étant par une latitude de 19° 52′ Sud et 50° 25′ longitude Est, le temps était magnifique, mais calme. Vers 7h. ½ du soir une chose rare se montra au firmament; une quantité extraordinaire de météores parurent successivement, se formant dans le Nord, allant dans leur course vers le Sud-Est. Les uns donnaient une clarté très vive et d'autres ne laissaient qu'une légère trainée de feu ressemblant á des fusées; mais tous allaient avec une grande rapidité. Ce manége de petits méteores dura jusque vers 2 heures du matin.

"Un autre fait non monis curieux s'etait présenté dans la journée. Tous les marins connaissent l'Alcyon (ou hirondelle de mer) et tous savent que ces petits oiseaux se tiennent dans les eaux du Navire, mais en petite quantité. Nous avons, pour ainsi dire, été assaillis par ces oiseaux, les uns voltigeant autour du navire et les autres posés sur l'eau assez près les uns des autres, ce qui ressemblait á une masse noire."

The above observations, with the exception of Capt. Gaston's, were all taken within a circle of three miles in diameter, and at altitudes of 700 to 1000 feet.

There are, as might be expected, some discrepancies in the accounts given, but it appears to me that the meteors were seen in two streams, the one passing through Aries, Pisces, and Aquarius, nearly along the Ecliptic, and the other through Orion towards Sirius, while others passed through the zenith from north to south.

The radiant point would appear to have been close to the stars o and ζ in the foot of Perseus, near the spot indicated by Mr. Newton and Mr. Bruce. Mr. Stein, however, probably from his seeing only a part of the sky, thinks there was no radiant point. I have not seen him since I received his description; but from verbal explanation given by Mr. Bruce and Mr. Marsh, and from Capt. Gaston's account I think the meteors shot from the above-mentioned point. Mr. Bruce informs me that he observed a meteor pass from Northward close to and parallel with ϵ and α Tauri; and Mr. Marsh mentions that he saw one pass from near the zenith right over Fomalhaut.

I think there must be some mistake in the statement that many meteors shot from Orion through the zenith to the meteor horizon.

With regard to the time of maximum intensity it must have been at 11, or soon after.

The shower was evidently not equal in splendour to that of November 14, 1866.

Watch was kept up during the night of the 28th to 29th, but the few meteors seen did not radiate from any point.

The number of the meteors seen from the 12th to the 15th was not greater than on ordinary nights.

On referring to Quetelet's Catalogue, I find mention of only three showers seen about November 27, one on November 25, (16th Jul. Cal.) 1602, a second on November 25, 1822, and a third on November 29, 1850.

While on the subject of meteors, I beg to send an account of an extraordinary one seen here by the Rev. Mr. Wright on the night of November 7 last. [See this week's Correspondence.] Mr. Wright's description, in several respects, applies to the moon, which was at the end of her first quarter, and in the part of the heavens indicated. Has any similar meteor been seen in former times? It was totally different in form and appearance from the great meteor of Nov. 27, 1862.

C. MELDRUM

Mauritius, Dec. 12, 1872

SCIENCE IN ITALY*

THE energetic revival of scientific activity in Italy, to which attention has been before directed, is still progressing satisfactorily. The mere fact that the Transactions of the Royal Institution of Lombardy report the proceedings of the sittings of the 24th June, of the 4th and 18th of July, of the "ordinary sittings of the 1st August," and "the solemn sittings of the 7th of the same month," afford to any Englishman who has *summered* on the Plains of Lombardy, very strong presumptive evidence of scientific enthusiasm and industry. Even in our lukewarm climate such meetings are suspended during the summer months, in spite of the insatiable activity of Englishmen. It does not appear that the worship of the "*dolce far niente*" has profaned the Milanese shrine of science.

In the course of these summer meetings thirty-nine original papers, besides academical reports and addresses, were read. During the year ending August 7, ninety such papers were read in the Department of the Mathematical and Natural Sciences, including subjects in pure and applied mathematics, hydraulic engineering, physical geography, astronomy, experimental physics, chemistry, natural history, animal and vegetable physiology, geology, agriculture, anthropology, anatomy, pathology, surgery, therapeutics, hygiene, medical statistics, and the history of science. In addition to these a number of original papers were read in the Department of Literature and Moral and Political Science. This statement of the quantity of work done is a sufficient excuse for my not attempting anything like a complete analysis of it. A few of the most interesting papers may however be mentioned.

June, 20.—"On the Anthropometry of 400 criminals in the Penitentiary of Padua." This is an analysis and a summary of the results obtained by Dr. Pellizzari and Dr. Berretta, the full record of which fills a large volume. Some curious results come out of the tables of these measurements. The tallest and heaviest men are those who have committed murder and manslaughter; the shortest and lightest those who have committed rape. The head measurements are very interesting and suggestive, sufficiently so to warrant a continuation of such investigations over an area sufficiently large to obtain more reliable averages than the 400 measurements afford. There is another paper of the same date by Dr. Giglioli, that I suspect will prove very interesting to comparative anatomists, on some remarkable teeth of whales (Cetodonti) that were collected by Sig. Corelli, among other things, during a residence of forty years at Rio de Janeiro.

July 4.—"On the epoch of the upheaval of the sienitic rocks of the chain of Adamello, in the Province of Brescia."—"On another analogy between electrical and magnetic polarity," by Prof. Cantoni. (Another paper in continuation on the same subject was read on July 18.)—Note on the "Heat of Combination of Bodies," by Prof. Cantoni. This contains some suggestive speculations on the philosophy of thermodynamics, in which the author points out experimental difficulties, and goes a long way in the direction of atom-splitting, in order to find an explanation. He compares the combination of two chemical atoms or molecules, to a collision between two stellar systems or nebulæ, where the development of heat would not be merely that due to the velocity of each system considered as a whole, but in addition to this, to the disturbance of rotatory and orbital motion of the planets, satellites, &c., within each system. He supposes the ordinary atom or molecule to be a system of minor atoms, having orbital and rotatory movements, the disturbance of which, when atomic collision occurs, contributes to produce the heat of combination. It is not for me, a heretical disbeliever in the existence of either atoms or molecules, to make any comment on the merits of such a hypothesis.

"On the Drainage of the Lago Fucino" by Carlo Possenti, refers to an important undertaking which is proceeding at the cost and risk of Prince Torlonia. The author points out the difficulties and possible sources of failure of the enterprise.

"On the Prediction of the Movement of Tempests and the Phenomena which accompany them," by M. Harold Tarry, Vice-Secretary of the Meteorological Society of France; communicated by Prof. Schiaparelli. This is an exceedingly interesting paper, mainly based upon observations made by the author on the great cyclones which have deposited in Italy some of the sand uplifted from the desert of Sahara, &c. It is worthy of a special and separate abstract.

* "Rendiconti del Reale Istituto Lombardo," for July, August, and September, 1872.

July 18.—"On the Velocity of Molecular Movements in Aeriform Fluids," by Prof. Brusotti. This is a contribution to the mathematical theory of thermodynamics.

"On the Origin of Atmospheric Electricity," a series of experiments on the electrical disturbances due to the rarification and condensation of air, both in its ordinary condition and when subjected to artificial dessication with a view to answer the question proposed.

"On the Burning of Dead Bodies," by Dr. G. Polli. The author points out many sanitary, economical, and sentimental objections to the existing customs of burying the dead, and advocates a revival of the ancient system of rapid decomposition by burning and preservation of the ashes, in order to satisfy sanitary requirements of the public, and the affections of friends and relatives.

Prof. Corradi contributed a long and interesting account of the voluminous manuscripts of Lazzaro Spallanzani, obtained in 1801 by the communal library of Reggio from Dr. Nicolo Spallanzani, the brother of Lazzaro. A perusal of this paper shows that the industry and attainments of this great naturalist were more extensive than we are accustomed to suppose in England. His manuscripts in Italian, French, and Latin are collected in 193 volumes, and include travelling diaries, notes of experiments and observations, letters, &c., some of which have been already published.

Besides these I may refer to Prof. Stoppani's observations on the eruption of Vesuvius April 24, 1872, and also to Prof. G. Cantoni's researches on the Rust of Wheat; but cannot attempt any account of their contents without extending this notice much beyond its proper limits.

The "solemn sitting" of the August 7 was chiefly devoted to the annual addresses of the Secretaries of the Mathematical and Physical, and of the Literature and Moral and Political Departments, Sig. Luigi Cremona, and Sig. Guilio Carcano, and to other annual business.

I should add that a monthly meteorological report is regularly published, with the Transactions of this society.

The papers in the Department of Literature and Moral and Political Science are few in number. Passing over the mere literature altogether, I may refer to one paper on a strictly scientific subject which in Italy, as in England, is too commonly left in the hands of mere talkers and writers, who *discuss* many things and *investigate* very few or none. I allude to political economy, and to a paper by Prof. Marescotti on Rent and Profit. This paper abounds in political argument, rather than political science. The author describes the rent of land as the remuneration of the landed proprietor for the capital which he has invested in rendering the soil productive, and although writing for the purpose of justifying the payment of rent, appears quite unacquainted with Ricardo's demonstration of the natural and independent origin of rent, as another element totally distinct from the reimbursement of the proprietors' outlay on the land.

The summer and autumn numbers of the *Gazetta Chemica Italiana*, and the Transactions of the Academy of Sciences of the Institute of Bologna must be reserved for another notice.

W. MATTIEU WILLIAMS

SCIENTIFIC SERIALS

THE *Geological Magazine* for the present month (No. 103) opens with a note by the editor on fossil remains of insects which have been described in previous volumes of the magazine, as an introduction to a paper by Mr. A. G. Butler describing a most interesting wing of a butterfly belonging to the Nymphalide group, found in the Stonesfield slate. This butterfly Mr. Butler proposes to name *Palæontina oolitica*, and, as he remarks, it is the most ancient member of its group yet discovered.—Mr. R. H. Tiddeman describes the Victoria Cave at Settle in Yorkshire, and notices the fossils contained in the lowest deposit yet reached in the investigation of this cave.—Mr. W. Molyneux notices the occurrence of copper and lead ores in the Bunter conglomerate of Carnock Chase; and Prof. King, of Galway, communicates a paper on the microscopic characters of a silo-carbacid rock from Ceylon, and notices their bearing on the methylotic origin of the Laurentian limestones, methylotic being a term introduced by the author to express the character of rocks which have undergone change by the elimination

of or additions to the substances of which they were originally composed. This paper, of course, bears indirectly on the vexed question of the nature of *Eozoon.*

Poggendorf's Annalen der Physik und Chemie, No. 11. The first paper in this number is by A. Wüllner, being a continuation from vol. cxliv. of his researches "On the Spectra of the Gases in Geissler's Tubes." The present paper gives an account of some researches undertaken by the writer along with Dr. Winkelmann to account for the origin of the different kinds of spectra, the band spectrum, the line spectrum, and the continuous spectrum. The spectrum experimented on was that of nitrogen, the media being air, hydrogen and oxygen respectively. The next paper is an abstract of a memoir by Prof. Lemström, of Helsingfors University, on the intensity of the flow of a voltaic current, which is followed by one in the department of acoustics, by J. J. Oppel, on two remarkable circumstances in connection with what he in a former paper called "Reflexionstöne" or "Gittertöne." The next paper is the first portion of the second part of Herr W. Sellmeier's paper on the subject of the vibration of molecules, which is followed by the continuation of E. Ketteler's elaborate memoir on the influence of astronomical movements on optical phenomena. The next paper is an attempt by L. Lorenz, of Copenhagen, to discover the means of determining in absolute terms, degrees of heat, and to show more clearly the relation in which heat and electricity stand to each other, which is connected to some extent with the paper which follows by S. Subic, on temperature constants. A few short papers conclude the number.

No. 12. The first article in this number is a long one by Dr. R. Börnstein, on the theory of Rühmkorff's induction apparatus, which is followed by the conclusion of the second part of Sellmeier's paper on the vibration of molecules. The next article is a criticism, by F. C. Henrici, on a paper read by Tomlinson to the Chemical Society, on the action of solid bodies on supersaturated solutions. E. Reusch contributes an article on the doctrine of twin-crystals, and J. Hervert one on transverse vibrating flames. V. Dvôrák contributes an account of some experiments to test Airy's theory of the Talbot bands. Among the shorter papers is one by F. Zöllner on the reversion spectroscope.

Mittheilungen der Naturforschenden Gesellschaft in Bern aus dem Jahre, 1871.—The first part of this goodly sized volume is occupied with the proceedings of the Scientific Society of Bern for 1871. The following are some of the longer papers which make up the bulk of the volume. The first is the continuation from a former volume of Dr. Cherbuliez' Historical Résumé of Researches on the rate at which sound is propagated through the atmosphere; the same gentleman contributes some historical notices concerning the mechanical theory of heat. Considerable space is given to the continuation and conclusion of Dr. H. Wydler's contributions to a knowledge of the indigenous plants of Switzerland; and L. Fischer contributes a long list of the cryptogamic plants to be found in the neighbourhood of Bern. One of the longest and most interesting articles is by E. Schaer, being contributions to the chemistry of the blood and of ferments; the first part treating of the influence of cyano-hydrogen and phenol on certain properties of the blood corpuscles and various ferments; and the second part on the action of cyano-hydrogen and phenol on yeast and on mould-fungi. This is followed by a paper by Dr. A. Forster on the colouring of smoky quartz or topaz. The concluding paper in the volume, which is accompanied by a well-constructed map and graphic tables, is by A. Benteli, who attempts to estimate the amount of moisture precipitated by the atmosphere in the seven chief river-districts of Switzerland. The volume is altogether highly creditable to the Society whose transactions it records.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, Jan. 16.—A "Note on an Erroneous Extension of Jacobi's Theorem" was read by Isaac Todhunter, M.A., F.R.S.

Sir G. B. Airy read an additional note to his paper "On a supposed Alteration in the Amount of Astronomical Aberration of Light produced by the Passage of the Light through a considerable thickness of Refracting Medium."

Some months since, he said, I communicated to the Royal Society the result of observations on γ Draconis made with the water-telescope of the Royal Observatory (constructed expressly for testing the quality of the coefficient of sidereal aberration, whether the tube of a telescope be filled with air, as usual, or with water) in the spring and autumn of 1871. Similar observations have been made in the spring and autumn of 1872, and I now place before the society the collected results. It will be remembered, from the explanation in the former paper, that the uniformity of results for the latitude of station necessarily proves correctness of the coefficient of aberration employed in the Nautical Almanac.

Apparent Latitude of Station

			°	′	″
1871.	Spring	. . . .	51	28	34·4
	Autumn	. . . .	51	28	33·6
1872.	Spring	. . . .	51	28	33·6
	Autumn	. . . .	51	28	33·8

I now propose, when the risk of frost shall have passed away, to reverify the scale of the micrometer, and then to dismount the instrument.

Mathematical Society, Jan. 9.—Dr. Hirst, F.R.S., president in the chair.—Papers were read by Mr. S. Roberts, V.P., on parallel surfaces; Prof. H. J. S. Smith, on the greatest common divisors of the minor determinants of a rectangular matrix of which the constituents are integral numbers, and on an arithmetical demonstration of a theorem in the integral calculus (these two communications were founded upon a paper by the author, published some few years since in the "Philosophical Transactions." Prof. Wolstenholme, on the summation of certain series (read in the author's absence by the secretary). This was concerned with the obtaining of a series closely related to Vandermonde's well-known series, ; thus, Vandermonde's series being—

$$(a+b)_n = b_n + n\,b_{n-1}\,a_1 + \frac{n(n-1)}{1\cdot 2}\,b_{n-2}\,a_2 + \ldots + a_n$$

then the series discussed might be written—

$$(a+b)_n = b_n + n\,(b-1)_{n-1}\,a_1 + \frac{n(n-1)}{2}\,(b-2)_{n-2}\,(a+1)_2 + \frac{n(n-1)(n-2)}{3}\,(b-3)_{n-3}(a+2)_3 + \ldots + (a+n-1)_n$$

Amongst the presents received were three War Department weather maps, Signal Service, U.S. army, Washington, Friday, November 22, 1872, constructed for 7.35 P.M., 4.35 P.M., and 11 P.M.

Chemical Society, Dec. 16, 1872.—Prof. Frankland, F.R.S., president, in the chair.—"Notes on various Chemical Reactions," by Dr. Davies, contained observations on the formation of the sulphides of copper and barium, also some notes on the separation of nickel and cobalt.—Mr. H. Grimshaw communicated the results of his researches on ethyl-amyl and its derivatives. After the president had made some remarks on the thoroughness with which this research had been carried out, a communication from Dr. Schorlemmer on "The heptanes from Petroleum," was read. This paper contained, among other matter, an interesting account of the separation of isomeric heptylenes by means of hydrochloric acid.—A paper by Mr. T. Cornelley on the "Vanadates of Thallium," was then read. It contained descriptions of several new and complex vanadates of Thallium.—Mr. Kingzett communicated to the society the results of his experiments on the conversion of sodium chloride into sodium sulphide by the action of hydrosulphuric acid; and finally, Mr. P. Braham exhibited some ingenious apparatus which he had arranged for the prosecution of physical researches under the microscope.

Photographic Society, Jan. 14.—James Glaisher, F.R.S., president, in the chair.—The President delivered a lecture on the application of photography for registering magnetical and meteorological phenomena, pointing out that no other method of registration was sufficiently delicate for the purpose; the lecturer explained that the magnetical records were obtained by a mirror arrangement fitted to the moving magnet, and in this way a pencil of light was reflected upon sensitive paper wound round a cylinder, which revolved once in twenty-four hours, thus securing a wave line representing the magnetical currents of the earth during the day. Meteorological records required less complicated apparatus. The photo-chemical process employed was also explained. Dr. E. J. Gayer read a paper "On In-

stantaneous micro-photography," and exhibited pictures of live animalculæ in water.—Dr. E. J. Gayer also read a paper "On a cause of fading in albumenised pictures."

PARIS

Academy of Sciences, Jan. 6.—This was the annual general meeting of the Academy, and M. Faye, after delivering an address mainly devoted to the transit of Venus expeditions, vacated the chair, where he was succeeded by M. de Quatrefages.—M. Le Baron C. Dupin read a note on the French population, which, allowing for the ceded provinces, shows a decrease of 1,279,451. The decrease the Baron asserts to have been directly and indirectly caused by the late war.—M. Boussingault gave an account of his experiments on the formation of nitric compounds by the soil. He finds that these bodies are not formed from the nitrogen of the air, as he had been inclined to think.—M. A. de Caligny read an interesting paper on the effects of certain kinds of waves on sand-banks.—Further observations of 128 by M. Borrelly were received, and also M. Bossert's Elements and Ephemerides of the same planetoid.—A paper on orthogonal surfaces, by M. G. Darbonn, was then read, and followed by an answer to M. Gernez's criticisms by M. G. Van der Mensbrugghe, who defends his and Mr. Tomlinson's theory of the action of films on saturated solutions.—A note on certain phosphorous compounds, in which that body appears to exist in the amorphous (red) form, by M. A. Gautier followed.—M. A. Houzeau sent a paper on the estimation of ammonia in coal gas.—MM. Estor and Saint-Pierre sent a short note on respiratory combustion. They have made experiments which prove intra-arterial as against pulmonary combustion.—M. Sanson sent a paper on the horse of the quaternary fauna, which was followed by a note by M. Diamilla Müller on the absolute magnetic declination at Tiflis, at Sevrova, and at Paris.—M. de Rouville sent a paper on the upper Jurassic formations of the department of L'Herault.

January 13.—M. de Quatrefages, president, in the chair. M. Jamin presented his fourth note on a magnetic condenser, a description of an apparatus he has contrived, by which the power of magnets is much increased.—M. E. Mouchez read a note on the rising of the Algerian Coast.—M. H. Resal sent a note on Savart's observation of the mutual influence of two pendulums.—MM. Troost and Hautefeuille read some researches on the Allotropic forms of phosphorus; they point out the similarity of the changes of vapour density in phosphorus when undergoing allotropic modification to those of cyanic; they also state that the sudden development of heat in the case of phosphorus when at the point of change has an exact analogy in the case of the acid mentioned.—MM. F. Bagault and Roche sent a note on a new process for the manufacture of steel. The process consists of decarbonising cast iron by means of rich iron oxide ores.—An interesting mathematical paper on orthogonal surfaces was received from M. G. Darbown.—M. Gernez controverts some assertions of Van der Mensbrugghe as to the effects of liquids of high surface tension on liquids of low tension. Van der Mensbrugghe asserts that when such liquids are in contact, if the first contains a dissolved gas it is compelled to liberate it.—M. Melsens sent a note on sulphurous and chlorosulphuric acid and on the combination of chlorine and hydrogen in darkness. The author saturated charcoal with chlorine, and then introduced it into an atmosphere of hydrogen. The two gases completely and quietly combined in absolute darkness.—M. Prenier sent a note on "Polypropylenic Carbides." These bodies are formed by acting on propylenic bromide by nascent hydrogen; their general formula is $C^{2n}H^{2n}$.—M. J. Chaulard sent a note on the spectroscopic examination of the chlorophyll in residues of digestion. This body does not seem to be broken up in the stomach, as its absorption bands are distinctly recognisable in the excrements of animals fed on vegetables.—M. Stan. Meunier sent a note on "The increase of mechanical forces in the star (now destroyed), from whence the meteorites are derived.—M. P. Fischer sent a note on the Jurassic formations of Madagascar.—M. Pisani sent a paper on the analysis of Lanarkite from Leadhills, Scotland; he asserts that the mineral is a basic lead sulphate.—M. Chapelas's note on the aurora of January 7, was then read, and followed by a note from M. Poiree, on the levelling of the zero of the flood gauges of the Seine.—A letter from M. P. Bert to the President concerning M. Faye's recent defence of the Bureau des Longitudes was next read. M. Bert says that he did not propose the total suppression of the Bureau, but that he said that as it had not answered the expectations of science, it ought to be replaced by a bureau whose duty (like that of the "Nautical Almanac" office in England), would be to publish the *Connaissance des Temps*, and this office should receive not more than 40,000 francs (per annum?)

DIARY

THURSDAY, JANUARY 23.

ROYAL SOCIETY, at 8.30.—Contributions to the History of the Orchins: Dr. Stenhouse —On the Fossil Mammals of Australia: Prof. Owen.—Notes on the Wide-slit Method of Viewing Solar Prominences: W. Huggins.
ROYAL SOCIETY CLUB, at 6.
ROYAL INSTITUTION, at 3.—On Oxidation: Dr. Debus.
SOCIETY OF ANTIQUARIES, at 8.30.—Implements of the Bronze Period: John Evans.

FRIDAY, JANUARY 24.

ROYAL INSTITUTION, at 9.—Analogies of Physical and Moral Science: Prof. Birks.
PHILOLOGICAL SOCIETY, at 8.15.
QUEKETT CLUB, at 8.
OLD CHANGE MICROSCOPICAL SOCIETY, at 8.30.—On the Senses of Insects: T. Rymer Jones

SATURDAY, JANUARY 25.

ROYAL INSTITUTION, at 3.—Comparative Politics: Dr. E. A. Freeman.
ROYAL BOTANIC SOCIETY, at 3 45.

SUNDAY, JANUARY 26.

SUNDAY LECTURE SOCIETY, at 4.—The Glacial Period; a Chapter in English Geology.—An Account of the Physical Changes which Great Britain has undergone since Tertiary Times: A. H. Green.

MONDAY, JANUARY 27.

ROYAL GEOGRAPHICAL SOCIETY, at 8 30.—Sistan. With an Account of a Journey from Bander Abbas to Meshed, through that Province: Major Gen. Sir Frederick Goldsmid —Note on the Comparative Geography and Ethnology of Sistan: by the President.
ENTOMOLOGICAL SOCIETY, at 7.—Anniversary.
MEDICAL SOCIETY, at 8.
LONDON INSTITUTION, at 4 —Physical Geography: Prof. Duncan.

TUESDAY, JANUARY 28.

ROYAL MEDICAL AND CHIRURGICAL SOCIETY, at 8.30.
CIVIL ENGINEERS, at 8.

WEDNESDAY, JANUARY 29.

LONDON INSTITUTION, at 7.—Musical Lecture.
SOCIETY OF ARTS, at 8.

BOOKS RECEIVED

ENGLISH.—The Gospel of the World's Divine Order: D. Campbell (Trübner).—Lectures on the Philosophy of Law: J. H. Stirling (Longmans).—The Botanist's Pocket-Book: W. R. Hayward (Bell & Daldy)—The School Manual of Geology. Second Edition. A. J. Jukes-Browne (A. & J. Black).

PAMPHLETS RECEIVED

ENGLISH.—Scottish Naturalist, Vol. ii. No. 9.—Food Journal, Vol iii. No. 36.—American Journal of Science and Art, Nos. 24, 25, for Dec. 1872 and Jan. 1873.—The Astronomical Almanack, 1873: W H. Hollis (Simpkin and Marshall).—Zoologist, No. 88.—Entomologist, No. 112.—Sermons in Sonnets: W. Whale.—Proceedings of the Zoological and Acclimatisation Society of Victoria, and Report of the Annual Meeting of the Society, held March 1, 1872, Vol. i.—Fifth Annual Report of the Executive Committee of the Manchester National Society for Women's Suffrage.—Journal of the Royal Horticultural Society of London, Part 11, 12, Vol. iii. 1873.—Practical Magazine, No. 1. 1873.

AMERICAN.—The Lens, Vol. i. No. 4.

FOREIGN.—Rendiconti, Vol. v. No. 19.—Bulletin de la Société Imperial des Naturalistes de Moscow.

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